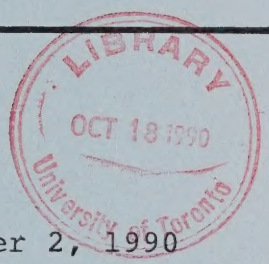
EA-87-02

Ontario

ENVIRONMENTAL ASSESSMENT BOARD



VOLUME: 241

DATE: Tuesday, October 2, 1990

BEFORE:

A. KOVEN Chairman

E. MARTEL Member

FOR HEARING UPDATES CALL (TOLL-FREE): 1-800-387-8810

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FARR & ASSOCIATES REPORTING INC.

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2300 Yonge St., Suite 709, Toronto, Canada M4P 1E4

EA-87-02

HEARING ON THE PROPOSAL BY THE MINISTRY OF NATURAL RESOURCES FOR A CLASS ENVIRONMENTAL ASSESSMENT FOR TIMBER MANAGEMENT ON CROWN LANDS IN ONTARIO

IN THE MATTER of the Environmental Assessment Act, R.S.O. 1980, c.140;

- and -

IN THE MATTER of the Class Environmental Assessment for Timber Management on Crown Lands in Ontario;

- and -

IN THE MATTER of an Order-in-Council (O.C. 2449/87) authorizing the Environmental Assessment Board to administer a funding program, in connection with the environmental assessment hearing with respect to the Timber Management Class Environmental Assessment, and to distribute funds to qualified participants.

Hearing held at the offices of the Ontario Transport Board, Britannia Building, 151 Bloor Street West, 10th Floor, Toronto, Ontario, on Tuesday, October 2nd, 1990, at 9:00 a.m.

VOLUME 241

BEFORE:

MRS. ANNE KOVEN	Chairman
MR. ELIE MARTEL	Member

A P P E A R A N C E S

MR. V. FREIDIN, Q.C.) MS. C. BLASTORAH) MS. K. MURPHY)	MINISTRY OF NATURAL RESOURCES
MR. B. CAMPBELL) MS. J. SEABORN) MS. B. HARVIE)	MINISTRY OF ENVIRONMENT
MR. R. TUER, Q.C.) MR. R. COSMAN) MS. E. CRONK) MR. P.R. CASSIDY)	ONTARIO FOREST INDUSTRY ASSOCIATION and ONTARIO LUMBER MANUFACTURERS' ASSOCIATION
MR. H. TURKSTRA	ENVIRONMENTAL ASSESSMENT BOARD
MR. J.E. HANNA) DR. T. QUINNEY)	ONTARIO FEDERATION OF ANGLERS & HUNTERS
MR. D. HUNTER) MS. S. BAIR-MUIRHEAD)	NISHNAWBE-ASKI NATION and WINDIGO TRIBAL COUNCIL
MR. J.F. CASTRILLI) MS. M. SWENARCHUK) MR. R. LINDGREN) MS. B. SOLANDT-MAXWELL)	FORESTS FOR TOMORROW
MR. D. COLBORNE) MS. N. KLEER)	GRAND COUNCIL TREATY #3
MR. C. REID) MR. R. REILLY)	ONTARIO METIS & ABORIGINAL ASSOCIATION
MR. P. SANFORD) MS. L. NICHOLLS) MR. D. WOOD)	KIMBERLY-CLARK OF CANADA LIMITED and SPRUCE FALLS POWER & PAPER COMPANY
MR. D. MacDONALD	ONTARIO FEDERATION OF LABOUR

APPEARANCES: (Cont'd)

MR. R. COTTON	BOISE CASCADE OF CANADA LTD.
MR. Y. GERVAIS) MR. R. BARNES)	ONTARIO TRAPPERS ASSOCIATION
MR. R. EDWARDS) MR. B. McKERCHER)	NORTHERN ONTARIO TOURIST OUTFITTERS ASSOCIATION
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MR. J.W. ERICKSON, Q.C.) MR. B. BABCOCK)	RED LAKE-EAR FALLS JOINT MUNICIPAL COMMITTEE
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MR. J.W. HARBELL) MR. S.M. MAKUCH)	GREAT LAKES FOREST
MR. J. EBBS	ONTARIO PROFESSIONAL FORESTERS ASSOCIATION
MR. D. KING	VENTURE TOURISM ASSOCIATION OF ONTARIO
MR. H. GRAHAM	CANADIAN INSTITUTE OF FORESTRY (CENTRAL ONTARIO SECTION)
MR. G.J. KINLIN	DEPARTMENT OF JUSTICE
MR. S.J. STEPINAC	MINISTRY OF NORTHERN DEVELOPMENT & MINES
MR. M. COATES	ONTARIO FORESTRY ASSOCIATION
MR. P. ODORIZZI	BEARDMORE-LAKE NIPIGON WATCHDOG SOCIETY

APPEARANCES: (Cont'd)

MR. R.L. AXFORD	CANADIAN ASSOCIATION OF SINGLE INDUSTRY TOWNS
MR. M.O. EDWARDS	FORT FRANCES CHAMBER OF COMMERCE
MR. P.D. McCUTCHEON	GEORGE NIXON
MR. C. BRUNETTA	NORTHWESTERN ONTARIO TOURISM ASSOCIATION

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---Upon commencing at 9:00 a.m.

MADAM CHAIR: Good morning. Please be seated.

Ms. Swenarchuk, would you object to entering as an exhibit now a presentation we received from a Mr. Trahan who made a submission to the Board in Hearst and he sent some extra material and I was going to give it an exhibit number.

MS. SWENARCHUK: Certainly.

MADAM CHAIR: This will be Exhibit No. 1410.

MS. SWENARCHUK: 1410.

MADAM CHAIR: 1410.

MS. SWENARCHUK: Is that where we're at?

MADAM CHAIR: 1410. This is a three-page typed submission by Mr. Robert Trahan, who is a branch supervisor of Employment and Immigration Canada in Hearst, who made a previous presentation on September 18th in Hearst and this is additional to that, and I am asking the court reporter to include it in the transcript. And there is also some appended material, and the parties can get a copy today.

---EXHIBIT NO. 1410: Three-page typed submission by Robert Trahan, with additional material appended.

THOMAS C. HUTCHINSON, Recalled

MS. SWENARCHUK: Good morning, Madam Chair, Mr. Martel.

CONTINUED DIRECT EXAMINATION BY MS. SWENARCHUK:

Q. Dr. Hutchinson, we left off yesterday looking at the Maliondo, et al, 1990 paper and at page 26 of that paper begins their discussion of the implications of whole-tree harvesting. Again, whole-tree in this paper refers to the practice that we describe in Ontario as full-tree.

Now, turning to page 27 of the report, the last sentence of the first, paragrah, the authors have said:

> "Thus practising whole-tree harvesting would result in marginal gains in biomass and losses of nutrients, especially of nitrogen, potassium and phosphorus, would be particularly high. In addition, losses in calcium and magnesium may be high in black spruce, white spruce, balsam fir and maple stands."

And is it your view, Dr. Hutchinson, that those comments would apply as well to sites in Ontario?

A. Well, some of the species -- they don't have red spruce there. Okay. I think the general conclusions would apply in Ontario, of course

it would apply in Quebec too.

They pointed out some general principles which seem to run right through their studies. They have looked at I think 24 different sites here of different vegetational composition, and from that they have come up with some generalizations and some which seem to be more specific to the species concerned.

The generalizations and the specifics to those species which occur in Ontario also I think would hold up.

Q. And they said in the first line of the next sentence that:

"The removal of large amounts of nutrients in the tree crown components by whole-tree harvesting may have detrimental effects on future site productivity."

And then they have listed a number of possible long-term effects. I would like you to look at those long-term effects and indicate whether you think those as well are problematic in Ontario.

These effects include possible long-term changes in soil fertility, that will apply in Ontario; would it, in your view?

A. Undoubtedly.

Q. And a potential increase in soil acidification?

A. That potential certainly exists here.

Q. They have said:

"Low soil fertility is assumed to occur in some natural stands in this region."

I take it from your evidence yesterday you would -- would you agree that that applies as well to some soils in Ontario?

A. Yes.

Q. "Causes for infertility vary but may include slow nutrient turnover in certain forest floors."

That applies as well here, Dr. Hutchinson?

A. Yes, I'm just looking at it. Yes.

Q. All right. If you would like to read that entire sentence.

"Causes for infertility vary, but may include slow nutrient turnover in certain forest floors, shallow rooting depth, acidic and coarse textured soils, nutrient-poor soil parent materials, purely drained soils and presence of rock outcrops."

A. Yes. Really one of the reasons of course that we are entering this is that the basic conclusions from this study, which includes a literature survey and a study of 24 sites in New Brunswick, are very similar to the overall conclusions which I have drawn in my witness statement.

Q. On the top of page 28, the first sentence of the page with regard to slash, the authors indicate:

> "Drastic curtailment of this source of nutrients as a result of whole-tree harvesting, especially if repeated over short rotations, may thus represent an irreversible loss in potential soil fertility, especially on poor sites such as some of those included in the present study."

Is it your view that the losses that we may experience in Ontario might also represent an irreversible loss in potential soil fertility?

A. It would, yes, in a sense. We have a number of recommendations on the very strong desirability of maintaining slash on the site, some of which have been answered in our witness statement, and these are from people from within Ontario, so I think

the maintenance of slash on site is very important to promote in this province.

The poorer sites that they list, actually we certainly have plenty environment, they describe these as shallow rooting depth, acidic sites, coarse textured sites - these would be gravels, sands - nutrient-poor soil parent materials - which would be equivalent to our pre-Cambrian Shield granitic rocks - and poorly drained sites, so we have lots of those.

So in all of the categories which they're referring to there is an equivalent in Ontario.

Q. Now, in the ninth line of that paragraph they indicate that:

> "Large nutrient losses caused by whole-tree harvesting will also be of concern in many sites in New Brunswick because inputs of nutrients from precipitation are low."

And I wonder if that condition, that inputs of nutrients from precipitation are low, also occurs in Ontario?

A. Well, inputs of nutrients from precipitation for most places are low, but of course precipitation goes on for a number of years, so it's a rather relative thing. I think the important thing to

remember about New Brunswick is that many of the air masses which are passing over Ontario are also passing over the Maritimes.

So that one of the regular summer features of air movements is that they're coming from the southwest to the northeast and they're also -- so they're coming up over Ontario.

If you just watch your television weather forecast in the evening you'll see the movement is very frequently from the central United States, across Ontario, Quebec and down through the Maritimes.

And that means that the deposition chemistry is likely to be quite similar. It also of course means that any inputs along the way such as from Toronto and so on into those air masses might be because of the travelway.

I guess what I'm saying is that though you will get local differences in rain, the regional patterns that we're dealing with, we're dealing with the same regional patterns in terms of soil and grain chemistry; that is, that it tends to be acidic, pH on average of about 4.2 in the rain for most of New Brunswick and it's quite similar for all of southern Ontario.

And the sulphate nitrate ratios are

somewhat different but combined we have the same amount of acidity of course.

Q. Now, the next four pararaphs are concerned with soil acidification, and I won't take the Board's time to read them into the record. I would like to ask you to review them to the bottom of page 29, first of all, Dr. Hutchinson.

Pages 28 and 29 beginning on the second paragraph of page 28, soil acidification.

A. Well, they say there are several sources of soil acidification, some are natural and some are anthropogenic.

The anthropogenic ones generally include precipitation; the natural ones would be the natural growth of trees, that the process of soil acidification is likely to lead to aluminum and hydrogenion mobilization, leaching, possible leaching losses.

"...acidification induced by whole-tree harvest partly results from the reduced neutralization acidity in the precipitation..."

MR. CASSIDY: I'm sorry, where is he reading from?

THE WITNESS: I'm sorry, I'm now reading the first paragraph of page 29.

MS. SWENARCHUK: The first paragraph on the top of page 29.

THE WITNESS: I wasn't reading for the first part, I just started reading. Okay.

"Regardless of these two factors, however, acidification induced by whole-tree harvesting partly results from the reduced neutralization of acidity in the precipitation owing to the loss of base cations content in the ground."

So they're saying that whole-tree harvesting with its removal of crown removes a lot of the potentially neutralizing bases which is what I was discussing yesterday. To continue reading:

"In contrast, slash from crown components left on the site during conventional...", that is bole-only harvesting, "...may continue to neutralize atmospheric acid inputs. The results of this study...", their study, "suggests that branches and foliage components represent a substantial amount of stand base cations. Most of the components that are rich in base cations will be removed from the

logging area during whole-tree harvesting. The impact of such removals may be higher for black spruce, white spruce and balsam fir than for other species."

And that's based on some of the analyses they've got of a whole host of different species growing in New Brunswick in which they find that black spruce, white spruce, balsam fir have a higher base status than jack pine, for example.

Now, do you want me to comment on this next paragraph too just in general?

"Whole-tree harvesting also increases soil acidification by altering microclimatic conditions..."

Q. If you would stop there, please.

A. Okay.

Q. And I just want to refer you as well to page 31, the next page over, and the second paragraph, eleventh line into the second paragraph when they say:

"In the short term, however, nutrient release from organic matter mineralization is likely to be higher in whole-tree harvested areas due in part to

the drastic changes in microclimatic conditions on the forest floor."

Can we just step back one moment, Dr. Hutchinson, and would you please describe for the Board what microclimate is and how, in your view, full-tree, or as they say, whole-tree harvesting affects microclimatic conditions?

A. Could you repeat the question, please?

Q. Yes. Before going through the Maliondo paper with regard to microclimatic change impacts, I would like you to step back and describe for the Board what microclimate is and how, in your view, full-tree logging affects microclimate?

A. Well, the microclimate that is under consideration here is the low to the ground changes in temperature, humidity, light intensity, which are -- well, these are close to the ground, short distance measurements, so we're talking basically here within about one metre from the ground.

And obviously if you take away any tree canopy, whether or not it's whole-tree or conventional, you're going to substantially alter the amount of solar radiation coming down to the ground surface. It will be a heating up effect during the day, but of course

you have also lost your insulating layer during the night so there will be increased daily fluctuations in temperature, so you'll have hotter during the day and colder during the night. These can be quite extreme.

Now, in conventional harvesting if you were leaving slash on site then you're leaving a whole series of, if you like, little microlayers in there which are going to mitigate some of the extremes. So you will kind of dampen the extreme noise of totally removing everything from site if you're leaving slash there, and you will also create a lot of little microhabitats where the humidity, for example, the relative humidity, the moisture content of the air will be much more favourable for tree outcrops, seeding growth or alder.

So the microclimate changes here will cause a heating up of the soil during the day, probably a retention of moisture in the soil initially following -- because you have reduced the evapotranspiration, reduced your water loss from your canopy. This is likely to speed up microbial processes.

You might have extremes. If you've got a hot summer day and the temperatures may be so high or the soil surface that it will inhibitory to growth. So

there's a complex of changes taking place.

Q. All right. You --

A. But the main point is that if we go from the in tact stand to conventional harvesting to full-tree harvest, that is a sequence of movement of your microclimate changes.

Q. Having discussed that then, could we look again at Maliondo's page 29, paragraph 2, and the discussion that begins:

"Whole-tree harvesting also increases soil acidification by altering micro-climatic conditions...", et cetera.

Do you agree that whole-tree harvesting tends to increase soil acidification?

A. Yes.

Q. In Ontario?

A. Yes.

Q. Now, turning to the top of page 31, and the question of whether the nutrients lost can be replaced, the authors indicate, and this is in the first paragraph:

"It is often suggested that the supply of nutrients from atmospheric inputs, mineral and rock weathering and mineralization of residual forest floor

might be sufficient to replace nutrients lost during whole-tree harvesting, however, it is unlikely that on many forest sites in New Brunswick the rate and amount of nutrients supplied by the first two sources will be significantly higher in the near future than in the previous rotations when most stands grew very slowly, partly as a result of low nutrient availability."

A. Right.

Q. Do those conditions as well, in your view, apply in Ontario?

A. Yes, they would. I think that this is a very important point that they are making here. They're saying that if you've taken away a large amount of your nutrient pool by removing canopies with the bole, then obviously you're starting in a somewhat deficit position, you've reduced your reserves substantially. You hope to get through the next generation, the same sort of growth rates that we have had in the present one is that there must be some additional mobilization or some additional inputs from the atmosphere.

What they're really saying is that this

seems most unlikely, that we couldn't anticipate that there will be an increase in nutrient additions from the atmosphere in the future unless, of course, we have some massive pollution episodes. The expectation is that the atmospheric inputs would remain about as they have in the past.

And the second point they're making is that presumably there would not be a major increase in nutrient mobilization from a rock and mineral weathering, and that since the trees in New Brunswick, they say, have been growing rather slowly, the expectation would be that with the fertility that was already there which you've now reduced from whole-tree harvesting, the reasonable expectation is that you will finish up with reduced growth in the next generation.

And the next paragraph continues this same line of argument.

"Furthermore...", reading the second paragraph on page 31,

> "...it is unreasonable to expect that the rate of nutrient supply from atmospheric inputs or from mineral weathering would be substantially higher in whole-tree harvested plots than in conventionally harvested ones."

That was going to be very, very amazing if it were.

"It is reasonable, however, to expect that in the long term nutrient release from organic matter mineralization...", that is break down of the organic matter,

"...will be higher on conventionally harvested plots than on whole-tree harvested plots because you have left more nutrient-rich logging slash on the site."

So in fact everything stacks up in terms of nutrient supply for the second generation against whole-tree harvesting and in favour of conventional bole-only harvesting, and there is absolutely no reason to suppose it would be different in Ontario.

Q. We have already looked at the remainder of that second paragraph. I just want to take one moment to refer again to the discussion that we had yesterday with regard to the use of fertilizers.

In the third paragraph of the page, fourth line, they indicate first of all:

"There is little experience of this practice, fertilization, on an operational scale in the Maritimes.

Further, that fertilizers are no substitutes for the organic matter and additional above ground biomass lost to whole-tree harvesting. In addition, it may not be justifiable economically especially when both the efficiency of fertilizer application and its use by trees in stands are low."

Do you agree with those statements as well?

A. Well, there has been experience with fertilizers in other places other than the Maritimes and there has been some experience there, so the experience is somewhat different but the conclusions about use of fertilizers, I think, are very reasonable.

Q. Okay.

MADAM CHAIR: Excuse me, Mr. Hutchinson, Mr. Martel and I have gone on a lot of site visits around the province and we have seen the situation you touched on yesterday where there is wood that is left on landings, whether it's -- often unmerchantable wood or whatever, but it's left on landings.

And you said yesterday, well if you could take some of that wood and put it back on the site rather than leaving it on the landing that would be

sort of a kind of fertilizer.

THE WITNESS: Mm-hmm.

MADAM CHAIR: If you were able to do that. And we had also seen on the landing chipping operations where the wood is mulched up. And Mr. Martel had made the observation - we had discussed this - that what kind of fertilizer would chipped wood provide in the sense of, I mean if you put entire logs back on the site and allowed them to decompose that would take some period of time.

If you actually put chips back on a site, would that be a more rapid form of decomposition and fertilizing them that way?

THE WITNESS: Well, wood would not be a great source of fertilizer on the sites.

MADAM CHAIR: It wouldn't.

THE WITNESS: It would not match up, as these various papers show, it wouldn't match up to leaving on site your slash which includes the needles and the foliage and the broad leafs and so on.

So the most desirable thing to achieve - in fact I think it's vital that we do - is that we leave on site the foliage and the branches. In this paper I think they quoted some of the percentages which are contained in these different tree species in the

canopy and branches alone.

MADAM CHAIR: So the log itself you're saying that the amount of nutrients is very -- is small compared to the leaves and the branches?

THE WITNESS: The foliage alone, foliage and branches it says here --

MADAM CHAIR: Which page are you on?

THE WITNESS: I'm sorry, page 26, second paragraph of the discussion.

MS. SWENARCHUK: And there is also a table --

THE WITNESS: Two thirds of the way down it says:

"Thus, foliage and branches accounted for 19-57% of the total biomass in merchantable trees."

And then on top of that you have the fact that they are nutrient rich. So you have sometimes a two or three fold content of nutrients in the canopy compared with the bole.

So if you've got on your landings -- if you have the access to chip material and put it back, that would help; I mean, that would be better than nothing, though there are some other considerations, but it wouldn't come anywhere close to the benefits of leaving your canopy on the site.

And the problem of course of trying to put things back is that you then have to have some way of putting them back and you have got to use some mechanical means of putting them back and this is likely to create some further problems on site.

So that's definitely sort of shutting the barn door after the horse has bolted. It may be a good idea for the next time but the horse has bolted when you put your canopy off site.

MADAM CHAIR: Thank you.

MR. MARTEL: Has there been any type of -- we have seen every type of harvesting I think possible and the types of equipment that are now being utilized out there. Some of the more sophisticated equipment of course does all the operation in one, but it doesn't bring it back to the landing.

Should there be greater concentration in ensuring that new equipment be developed that in fact would limb and leave everything on site as opposed to bringing it back to a landing and then start the process?

THE WITNESS: Well, I think such equipment already exists actually.

MR. MARTEL: Yes, but it's not being used everywhere; is it?

THE WITNESS: No. I don't think in terms of what we have done in the past that this would represent -- I mean, we have moved very rapidly into full-tree harvesting, very rapidly.

MR. MARTEL: Yes, which means that you are no longer leaving as much material on the site as you did previously.

THE WITNESS: That's right.

MR. MARTEL: With much more sophisticated equipment today than we had 15 years ago.

THE WITNESS: Right, but it's sophistication is in terms of extraction and removal from site and, you know, the scale at which it handles things.

MR. MARTEL: But the point I'm making is that they do get that equipment in there now, they can get equipment almost into all sites.

And the question is: Why, when you have this type of equipment, what's behind bringing it to the landing before you start to do all the prossess? Why has the emphasis been - and I used to be one of those who believed, quite frankly, that it was better if you did bring it away because it made the forest a lot cleaner and much easier for people to go through and animals to use and what not - until we started the

whole -- listening to all the argument about: Well, if you remove it you don't have as much nutrient, so the question is: What do you do?

I mean, if we are going to reduce the efficiency of reproduction by removing it, there's an option, you leave it there. There aren't very many options available to you.

THE WITNESS: I think perhaps, partly by accident, we have moved rapidly in the direction of non-sustainability. Certainly on the nutrient-poor sites we have moved in that direction and it's a very bad direction, in my opinion, from all kinds of points of view.

We would have to live I think with some of the aesthetics that some people get upset about of having slash on the site, especially not slashing piled up into windrows but slash dispersed on sites is probably the best way to have it from an ecological point of view and from the point of view of sustainability.

So really in the interest of the forest industry, it's better to have it dispersed on site for the next generation.

MADAM CHAIR: With respect to windrows, you would rather see it dispersed, but you would rather

see windrows than having the slash removed entirely?

THE WITNESS: Yes, that's right. Now, if we could achieve all of that with minimum disturbance on site and we're just taking boles off then - I really haven't come across many reports which are suggesting that bole-only harvest is a bad thing - obviously it's vital that we do that anyhow, but ecologically, from a nutritional point of view, there seems to be very little objection to it.

Now, there may be some cases on very poor sites when we shouldn't be harvesting at all, but that's a somewhat different question.

MR. MARTEL: And the thing that triggered Mrs. Koven's question, of course, is having reviewed the films last week of some of the presentations and having been out in the forest many times ourselves and seeing the boles that are left there from poplar that wasn't utilized or something that was killed when you were using chemicals, it seemed part of the solution might be to knock it down and chip it right there, so that in fact rather than have logs that are going to take a hundred years to rot and decompose that you would be better off quickly chipping it and making regeneration that much simpler.

THE WITNESS: Well, logs decomposing,

apart from some of them around Sudbury actually, they generally decompose a bit faster than a hundred years.

MR. MARTEL: We fossilize them there.

THE WITNESS: There's some famous ones at Falconbridge that have been there about 70 years and haven't start to decompose. But aside from that, the nutritional requirements of the first stems increases over time to a kind of optimum. So though, you know, from our sort of point of view it seems nice if we can deliver the fertilizer early, that isn't actually the best way of delivering it because the tree species you are attempting to cultivate have limited nutritional requirements in those first few years, and as they begin to move up to canopy closure, the nutrient requirements build up.

So the nice way to do it is the way actually nature does it, with a generally slow release over time. Again, aesthetically this doesn't look terrific, but maybe we need to educate the public that that's, you know, if they want to be green that's the way to go.

MR. MARTEL: But that's a perception in the public's mind that when you leave all that there that it's really bad practice.

I mean, if you talk to the general public

their opinion about what's going on in the forest and they see that, it is a real source of irritation.

THE WITNESS: But isn't that aesthetic?

MR. MARTEL: Yes.

THE WITNESS: They think that, well, it looks a mess.

MR. MARTEL: Yes, right. So they think it's bad.

THE WITNESS: So they think it's better actually to drag it all to some place and burn it.

Well, that's not good, it's like trying to keep something that looks like Edwards Gardens, you know, but it's actually a forest.

Anyhow the point that they're making at the end of this paper that we've just referred to is that whole-tree harvesting is most unlikely to be -- and nutrient loss is most unlikely to be replaced by some acceleration of mineralization or rock weathering or of atmospheric inputs. That's whistling in the wind frankly, to hope that.

MS. SWENARCHUK: Before we go on, Madam Chair, Mr. Martel, I just wanted to, for your assistance, direct your attention to Tables 6 and 7 on pages 14 and 15 of the Maliondo article which indicate the distribution in percentages of nitrogen and

phosphorus respectively in above ground tree components of the stands used for the study in New Brunswick. And I think the tables make evident the --

MR. FREIDIN: Well, I think if she wants to lead evidence, that's one thing; if she wants to ask the witness to interpret the tables and ask the witness what the significance of the tables are, I have no objection, but I don't want to hear the evidence from Ms. Swenarchuk.

MS. SWENARCHUK: I'm crushed.

Q. Dr. Hutchinson, could you just explain very briefly for the Board how the tables on page 14 and 15 relate to the discussion we have just had about the usefulness of leaving foliage and branches on the site after harvest?

What do those tables enumerate?

A. Okay. They have got two tables, table 6 and table 7, pages 14 and 15.

If we look at the one for nitrogen first, table 6, they have set it out by species that have been harvested and they have got the site numbers - obviously many of these are different sites - then they have looked at the total nitrogen in above ground tree components, so the total nitrogen for the sites is given in kilograms per hectare, then they have looked

at each of the tree components; foliage, branches - moving across to the right - stem wood and stem bark, and they have presented this as a percentage of the nitrogen total.

I think the point that Mrs. Swenarchuk was thwarted in making is that the foliage components are very hard as a percentage of the nitrogen, and if you look across at the other table for phosphorus it's a rather similar situation.

Indeed if you look at black spruce you'll see that the percentages of the total nitrogen in the biomass exceeds 50 per cent for both nitrogen and phosphorus, as a matter of fact.

Some other species have lesser percentages because more -- now, this is a percentage, these are not actual numbers, these are percentages of the total, so if you look down at maple you may be surprised that the foliage components are somewhat lower but there's more of the nitrogen in other components of the maple.

So if we are whole-tree harvesting black spruce, white spruce, balsam fir down to jack pine for nitrogen, at least in the New Brunswick stands, we are taking away with the foliage alone, never mind the branches, more than 40 per cent of the nitrogen and we

are taking away in excess of 40 per cent of the phosphorus.

If we add on branches, which also will be taken off site, stem wood and bark, then we're adding a very high -- well, if we just add foliage and branches as part of the slash taken off site we are in excess of 60 per cent taken away that way.

And they have tables -- if you wish to look any further, they have tables on pages 17, 18 and 19 which go through similar sorts of analysis for the potassium, which is another of the big three essential elements and for calcium and magnesium and you will see that there is an impressive, may be disturbing, quantity of these essential elements held within the foliage in every one of those cases.

I think the message is clear about removal of foliage from site.

MADAM CHAIR: Excuse me, Dr. Hutchinson, could you just -- on tables 6 and 7, can we just look quickly at the difference between the distribution in trembling aspen versus the spruce.

THE WITNESS: Okay.

MADAM CHAIR: And the point you made yesterday had to do with the difference in foliage and the difference in dropping leaves in the fall and so

forth.

THE WITNESS: Right.

MADAM CHAIR: Now, if you were going to use aspen as the example of the species that you might want to keep on a site, if you had a choice -- if it were possible you would keep the whole tree on the site as slash.

THE WITNESS: Mm-hmm.

MADAM CHAIR: And if that wasn't possible, then the logs themselves, the stem wood and the stem bark consist of relatively higher amounts of nutrients than--

THE WITNESS: In the trembling aspen.

MADAM CHAIR: --than does the spruce?

THE WITNESS: Right, that's correct. So that, if you like, the wood of spruce is nutritionally poor compared to the wood of trembling aspen.

MADAM CHAIR: Thank you.

MS. SWENARCHUK: Madam Chair, may I have a moment, please.

THE WITNESS: I think that's probably why beavers like eating trembling aspen and poplar.

MS. SWENARCHUK: Madam Chair, may I have a moment, please?

MADAM CHAIR: Pardon me?

MS. SWENARCHUK: May I have a moment's break, please?

MADAM CHAIR: Yes.

---Discussion off the record

MS. SWENARCHUK: Q. Now, in your witness statement for Panel 1, Dr. Hutchinson, one of the sources you used in the paper was Likens, et al in 1970, and this I think is part of the famous Bormann and Likens team; is it not?

And I understand that you have as well a summary article from Bormann and Likens that you would like to refer to on this question of nutrients.

A. Has this been distributed?

Q. It has not yet.

A. Oh, okay.

MR. HUFF: (handed)

MADAM CHAIR: Do you want this to be made an exhibit, Ms. Swenarchuk?

MS. SWENARCHUK: Yes, please, Madam Chair.

MADAM CHAIR: This will be Exhibit 1411.

MS. SWENARCHUK: Q. I understand, Dr. Hutchinson, that this is an excerpt; is it not, from the book by Bormann and Likens entitled: Pattern and Process in a Forested Ecosystem; correct?

A. Correct, yes.

MS. SWENARCHUK: Pages 222 up to and including 227.

---EXHIBIT NO. 1411: Excerpt (pps 222-227) from book entitled: Pattern and Process in a Forested Ecosystem, by Bormann and Likens, 1979.

MR. CASSIDY: Is there a date on this document?

MS. SWENARCHUK: The date is 1979; is it not, Dr. Hutchinson?

THE WITNESS: I think so. Yes, 1979.

MADAM CHAIR: Do we have other excerpts from this book in exhibit?

THE WITNESS: No, no.

MS. SWENARCHUK: I would have to check the exhibit list, Madam Chair, to see whether other excerpts have been made exhibits earlier in the hearing. If that's a possibility, I'll check that, but not in our material to date.

MADAM CHAIR: It's just helpful when we get articles that we know we can cross-reference the authors and know that we've read them before.

MS. SWENARCHUK: Yes.

MR. CASSIDY: Madam Chair, the article which we were provided yesterday for the first time,

I'm in the understanding it came out after the witness statement was produced. Am I to understand that is not the case with respect to this exhibit, 1411?

MS. SWENARCHUK: That's correct.

MR. CASSIDY: Well, having seen this document for the first time, Madam Chair, we're in a situation where we're being served with a paper that was not provided in the witness statement or the source books.

Now, I'm not in a position to say whether or not I'm prejudiced because I just got this two minutes ago and I want it noted for the record that that is going to require me at some time to review this with my advisors, and I'll advise you accordingly if that's the case.

MS. SWENARCHUK: Madam Chair, it has frequently been the case in the process of this hearing that materials have been produced by witnesses subsequent to the filing of their witness statement if in fact those materials did not form part of the preparation of the witness statement.

In fact we can recall instances where new witness statements were filed when the witness appeared to testify.

It's absolutely not our intention to

prejudice any party and certainly where this material has come to the witness' attention and is of benefit to the Board, I think the practice of this Board and certainly any other judicial or quasi-judicial process is to assure that the other parties have the necessary time that they need to review the document for the purpose of their, for example, cross-examination.

In the case of Mr. Cassidy, I would assume he would not even be commencing cross-examination until a week from now. If any other arrangement is necessary to preclude any prejudice he may experience, we would of course be totally cooperative.

There is a possibility that there is another excerpt from the text as Exhibit 674. The exhibit list doesn't indicate what segment of the text that is.

Q. Dr. Hutchinson, would you proceed then to explain to the Board how it is, in your view, that this material is of assistance on this issue?

A. Well, the studies by Bormann and Likens have been referred to I think quite frequently during the evidence presented to the panel. Now, this is just another -- this is actually a summary of some of their findings. So I think I had already referred

to two of their papers in the witness statement, so this is a summary which they put in book form of their findings.

I think it's useful to see what they felt about the situation, having carried out about 12 years of research onto the effects of clearcuts and nutrient losses from sites which were done in very considerable detail, and they have also produced a little model there which you see on page 222 Figure 8-21 in which they make predictions as to what the consequences are for nitrogen losses from site and for nitrogen availability for subsequent generations of different kinds of practices.

So they deal with simply conventional bole-only cuts versus full-tree harvest. So this is pertinent to what we're talking about.

If you look at the figure, the little dotted line A to B indicates the nitrogen losses as a result, in the top one -- the top of the four little examples, A to B indicates the losses from sites by bole-only harvest.

A to B in the second one indicates nitrogen loss from conventional -- from full-tree harvest, and they are looking at recovery times B to C -- let me just make sure I read it correctly first.

The rates of nitrogen B to C are the additional rates of loss as a consequence of the harvesting.

Okay, so one is removal from site, the second one is consequence of harvesting subsequent losses on the site from lateralization, percolation, et cetera, and then there's a recovery phase during which, which is C to D. And very simplistically they're pointing out I think the obvious, that if you cause a large depletion in your nitrogen reserves as a result of full-tree harvesting followed by further losses on site from the speeded up microbial processes, then the recovery time necessary is going to - this is all probably self-evident - the recovery time necessary is going to be substantially increased.

And I think you can see in a relative scale - which they haven't put on there - a relative figure is that the conventional harvesting is going to allow much more rapid recovery of nitrogen.

If we turn over the page and look at some of their conclusions on page 225, it might be relevant to what has occurred in Ontario. If we look at the fourth paragraph down on page 225:

"Within this framework, intensive study should be launched to estimate the energy

costs, economic benefit and environmental impact of new harvesting techniques. This should be done immediately before large amounts of capital are committed to whole-tree, complete-tree or puckerbush harvesting and the related processing."

Puckerbush is really taking the scrub and brush off site and using this.

"Experience in the last decade suggests that once a heavily financial commitment to new technology is made reasons will be found to continue its use."

Then they have a discussion on the acceptability of clearcutting, which I think indicates that at least they have an open mind on the matter, and on page 226 they make a series of recommendations which I would like to have a look at.

Series of recommendations for clearcutting, stem only, systems to be acceptable. Item 1, page 226:

"1. Cutting should be limited to sites with strong recuperative capacity. Clearcutting on steep slopes or on thin soils can lead to long-term changes in

the structure of metabolism and biogeochemistry of the forest ecosystem." Of course they working in hilly sites in Hubbard Brook.

"This was shown dramatically in the deforestation experiment at Hubbard Brook in which small patches of forest with thin soil on bedrock were converted to bare rock by the accelerated erosion that followed cutting.

2. Cutting should be done in the context of a larger watershed unit in relation to all previous cuts in the unit. This will allow the maintenance of water quality by dilution and by purifying activities within the drainage streams."

So the implication is that we should look at watershed units in terms of cuts and certainly make decisions, which means you're not cutting a large percentage of the watershed at any one time. And, in fact, in some other places they have recommendations I think on 10 per cent, 15 per cent of the watershed as a kind of maximum.

Q. Could you slow down a little, please, Dr. Hutchinson.

MR. MARTEL: Could you just repeat that last part about the effects of cutting the watershed.

THE WITNESS: Well, if you carry out, even if you conventional cut, you're exposing the ground directly to precipitation and you're also from the disturbance of the cutting increasing the probability of erosion taking place. So these two factors are likely to lead to sediment of particle loss from site, increased water flow from site - because you have no longer got your canopy as an interceptor - and also loss of nutrients from site insulation.

Their thinking is that if we maintain substantial percentage of the watershed at any one time then we can cut across it, as long as we don't do the whole thing at once. If we do the whole thing at once or anywhere close to it, then in fact they would suggest that you should be cutting substantially less than 50 per cent at any one time.

If you don't do that, then you are likely to accelerate water nutrient losses and sediment losses and accelerate erosion and so on. And, of course, the greater the slope the more likely you are to run into this sort of problem, depending on soil type and bedrock characteristics.

So the suggestion that there should be a

conservative approach to clearcutting. And they continue on this theme. Number -- does that answer your question?

MR. MARTEL: Yes, thank you.

THE WITNESS: No. 4.

MS. SWENARCHUK: Q. No. 3, first, Dr. Hutchinson.

A. Sorry, No. 3.

"3. Cuts should be relatively small, for example, several hectares to ensure the availability of seed sources and to minimize losses of dissolved substances and eroded material."

Q. Could I just stop you there.

A. They do this in the White Mountains in New Hampshire.

Q. And what are the species in those forests?

A. Well, the ones they're working with there runs from red spruce, hemlock, balsam fir on the upper slopes, into yellow birch, sugar maple, American beech and black cherry. So it's really going from coniferous mixed forests into more pure maple beech forests in these areas. Okay.

"Two methods of clearcutting, block

cutting and progressive strip cutting, are under study at Hubbard Brook", this was in 1979.

"Block cutting is a complete clearcut done all at once. In progressive strip cutting all trees are harvested over a four- year period. The forest is divided into a series of 25 metre strips and each third strip is harvested at two-year intervals. Preliminary data indicated that accelerate water nutrient losses may have been significantly reduced by progressive strip cutting."

That is even in the sloped areas of Hubbard Brook.

"4. The cutting and harvesting procedure should do minimum damage to the forest floor. This will safeguard the natural regenerative capacity of the ecosystem and sustain area-wide control over erosion."

The larger the area that you haven't got cut of course, the less erosion you are likely to run into.

"5. Roads should consume an absolute

minimum amount of area, commensurate with sound ecological and engineering principles.

6. Mechanical damage to the stream channel should be avoided by leaving a sufficiently wide strip of uncut trees along both banks.

7. Proper ecological weight should be given to species such as pin cherry, raspberry, elderberry...", which are all shrubs, "...which have little importance as a source of wood products. These exploitive species...", that is, they come in rapidly after cutting, "...play an important role in the recovery process by conserving nutrients."

So they pick the nutrients up rather than being lost from site.

"And minimizing erosion and are also an important source of food for wildlife."

We have some different species in the boreal forests, of course, but they play similar roles to those exploitive species they are talking about.

Q. And what species are those, Dr. Hutchinson?

A. Well, probably there are things like alder and some of the birch and trembling aspen and things like that that come in very rapidly.

A. No. 8:

"Planned rotation time should be long enough for the ecosystem to regain by natural processes. Nutrients and organic matter equivalent both to that lost as a result of product removal and to those losses accelerated by clearcutting."

That is the ones that occur post-cut on site.

"Current studies in the White Mountain region suggest that on the average about 65 years is required for organic matter in the forest floor to rebuild to pre-cutting level. Hence, we suggest...", that is Bormann and Likens, "...that a rotation time in excess of 65 years is compatible with natural regenerative processes. The United States Forest Service guidelines for management of timber harvest in the White Mountains National Forest suggests 110 to 120-year rotation for cutting."

They in fact suggest from their

ecological studies this could be reduced to about 65years.

Q. A couple of questions arising from those recommendations, Dr. Hutchinson. With regard to paragraph 3 and the last sentence that accelerated water and nutrient losses may be significantly reduced by progressive strip cutting, would you expect that to be true of sites in the boreal forests of Ontario as well?

A. Yes.

Q. And with regard to paragraph 8 and the rotation time, the recuperative period of time for the system to recover by natural processes, would you expect that cycle to be longer in the Ontario boreal forest than in the forest that Bormann and Likens are describing?

A. Well, that's a tricky question. If we -- well, it depends on which parts of the boreal we are dealing with and whether we are dealing with jack pine and things of that kind.

But I think the recuperation on our sites might take longer because we are starting off with sites which are, generally speaking, more nutritionally poor than the sites they're looking at.

Q. Any other further comments you wish

to make from the Bormann and Likens article?

A. No, I think that is it.

MS. SWENARCHUK: Madam Chair, when did you plan to take your break this morning?

MADAM CHAIR: It's been a long time since we had a regular schedule, but I think our breaks are twenty after ten to twenty to eleven.

MS. SWENARCHUK: Q. Now, we introduced the subject of watershed and related harvest practices in the Bormann and Likens article. I would like to turn your attention now, Dr. Hutchinson, to the question of hydrological impacts of clearcutting, you've described this beginning at page 22 of witness statement No. 1?

And I wonder if you could just summarize your thoughts regarding changes in site hydrology following clearcutting?

A. Well, in terms of accelerated loss of water from site that is increase in flow rates into streams and rivers adjacent to clearcuts, particularly substantial clearcuts, then there is an accelerated loss of water in sites.

An increased flow rate, not surprisingly it's greatest during the first year and it's sometimes also almost equally high in the second year, but the

first two years are the years in which you have your highest water losses from site.

And that of course is due to the fact that you've had your vegetation removed, you've got open ground available for rain to run off and for snow to run off, so it's not retained so adequately on site. And again, of course, you've reduced your evapotranspiration, you've reduced your loss of water back into the atmosphere from the vegetation and you've reduced your retention of water within the vegetation itself because you've removed your vegetation.

Sometimes that's -- particularly if we have coincidence of storms occurring, then sometimes this water loss can be very, very rapid and that can cause erosion on site because if you have surface water moving it will pick up any exposed siltants and clay fragments and tend to move them off site so you can get into gullying, you can get into loss of particulates and suspended sentiments from the site, and this is a common observation.

In terms of nutritional losses, the water doesn't go out as distilled water it dissolves things on route and so, of course, there's a nutritional loss associated with this. There's two ways of looking at it; one is in terms of the concentration which is

discharging in the streams and rivers, and that has some consequences for nutrient enrichment of these water bodies; that is, there's a potential for eutrophication to occur as a result of water losses from site.

It also of course increases your nutrient pull down or loss from your site and that is already, in the case of full-tree harvesting, substantial. So this is an additional factor that occurs.

In the various studies that we have quoted here the Likens study and the studies from Ontario by Nicolson and Nicolson, Foster and Morrison, 1982, they referred to - over pages 22 to 26, and I think to 27, yes, on to 27 in my witness statement - they find...

So if you have the same concentration in a larger volume of water you're removing more nutrients, but they also find that you've got an increased concentration, the regular feature is to find there's an increased concentration of nitrogen especially in the form of nitrate and ammonium and increased concentration. And increased flow from site means a quite substantial increase in some cases of nitrogen loss from site; and, again, this is unfortunate if we're dealing with many boreal forested

sites which have nitrogen deficiency. So this whole set of circumstances tends to nutritionally degrade the sites.

Now, some of this can be -- as Likens and Bormann have suggested, having shelter belts or having buffer zones along streams and so on will reduce some of the erosional aspects of it, but it's most unlikely -- unless you've got very substantial belts, it's most unlikely to reduce the soluble component loss from the site and the nitrogen ammonium losses that I'm talking about are soluble components not particulates, not suspended solids.

Well, let's just -- maybe we can just take a moment to look at the Nicolson conclusions. Okay, that is on page 25 of my witness statement, starting immediately beneath the table.

So Nicolson examined the effects of clearcutting on stream quality in a boreal forest site north of Kenora. He reported on several jack pine/black spruce catchments which had been clearcut and were 35 to 170 hectares.

He points out that these were sandy loam sites, coarse grain with gravel and cobbles. Comparisons were made between uncuts and between run-off and the water quality of one- and two-year-old

catchments, that's the first two years after cutting.

He found in the first year stream temperatures were increased on average five degrees celsius following cutting because of lack of shading of the site and this caused a high of 27 degrees in July.

The pH or suspended sediment loads were twice those in a oneyear cut compared with an uncut area. So this is one of the points I was making, that you have this potential for losing sentiments into streams following any site disturbances including clearcutting. Here he's talking of clearcutting.

PH in a one-year cut averaged 4.97 - that's almost 5 - compared with 5.76 in the uncut. That is, there was acidification of the stream. While the stream pH in the two-year old cut was 5.22, that is still more than half a pH unit less than -- that's five times the increase in hydrogenion concentration, compared to the uncut site. That's quite a significant increase in acidity -- acidification.

The dissolved carbon in streams was two and a half times that in the one-year cut compared to the uncut. This is organic loss of carbon from site.

All the elements he measured, that's 11 in all, except for manganese, were elevated in stream waters in the year-old cut areas.

In the two-year old cuts we still have elevations in nitrate, chloride, potassium, magnesium calcium and iron. Nicolson's concern is whether the increases caused concentrations to exceed the Canadian drinking water standards, and they did not. So in terms of water quality for drinking, it was still acceptable, but if we look at this from a nutritional point of view of the site and for the possibility of growing an equal forest stand subsequently, it's obvious that these losses will be adding to the removal from site of nutrients.

So we have the same organic and nutritional leakage from the clearcut sites as those reported for the hardwoods and mixed wood sites in New England, that is the Bormann and Likens study.

In a subsequent paper, Nicolson, et al presented more data from this same study. They showed monthly flow rates to be substantially increased in the clearcut watersheds. The average increase was about, I think it was 102 per cent. It showed nutrient increase in streams continued - now, they're looking over a longer period - they showed the nutrient increases in streams continued for at least four years, especially for the nitrogen components and for total phosphorus. So, unfortunately, again we're hitting on nitrogen and

phosphorus which are two of the major essential elements of plants.

Increased losses over time also occurred - next paragraph - for calcium, magnesium potassium, sodium, sulphate and chloride. The increased losses they attribute to the breakdown of the excess biomass accumulation due to the cutting. So this is decompositional losses. These were bole-only cuts.

They state:

"Even with conventional practices, a substantial proportion of the readily available pool of nitrogen and phosphorus for future plant growth is lost. With respect to potassium, calcium and magnesium, 7, 23 and 17 per cent respectively of readily available reserves in the biomass and soil are removed."

Q. More slowly, please, Dr. Hutchinson.

A. "If more complete utilization occurs where all or any of the crown, stump and roots are taken, such as in whole-tree or full-tree harvesting, more than double the amount of nutrients will be removed

from the site. Losses by crop removal are of a much higher order than those lost through the drainage waters."

So this is something else that we have to be aware of, we have to take this into account when we're making decisions on cutting practices and on the uses of the forest, that we have to recognize the fact that cutting inevitably leads to nutrient losses through the water bodies too.

I should say that these people, Nicolson, Foster and Morrison are all scientists with the Canadian Forest Service.

Q. One further question on this subject, Dr. Hutchinson. In your view, is the size of a clearcut of any importance in determining the hydrological consequences to the sites following clearcutting?

Is the size of the clearcut of any importance?

A. Well, you will increase the run-off from the site as a direct reflection of the size of the clearcut, and the important thing to bear in mind then is perhaps the percentage of that of the watershed, if we're dealing with watersheds, but the bigger the clearcut, the greater the flow rates that will be

experienced subsequently.

MADAM CHAIR: Excuse me, Dr. Hutchinson. Can you think of any situation with harvesting where the water level would drop as a result, rather than have an increased flow?

THE WITNESS: I think the general experience is that water levels -- water tables on site tend to increase following clearcutting. I don't think I can think of an example of it falling.

Now, that's not to say you don't get some drying out of the surface because of the increased exposure to solar radiation. So you can get great fluctuations in temperature and you can have surface drying out, but the water table itself comes up and sometimes comes right up to the surface depending on the site, sometimes exceeds it.

MS. SWENARCHUK: Q. Now, commencing at page 29 of your report, Dr. Hutchinson, you referred to a report which is Exhibit 1156 in the hearing and was presented during the Industry's Panel 8.

I don't intend to have you go through your comments on the report as you have written them in the witness statement, except if we could look at your conclusion.

A. Right, okay.

Q. At page 30 in the last paragraph. Would you read that into the record, please, beginning with, "The Nicks study which is a post-cut..."

A. "The Nicks study which is a post-cut, post-stocking investigation --

Q. Slowly for the benefit of the reporter.

A. Oh.

"...tells us nothing of what the consequences of these clearcuts were to the sites, to soil organic losses, nutrients losses, changes in microclimate, alterations in wildlife numbers. Nor is microclimate measured nor soil depth and quality, etc."

This is fairly illiterate I have to say.

"It is limited by its nature to answer only one question, i.e.: What are the sizes and density of jack pine saplings on two sites which had comparable size clearcuts and were restocked five and seven years ago."

There's a number of questions which could account for the findings which we have no information.

"Perhaps the central areas of the cut

were on deeper soil...", perhaps unlikely but it could be, since we don't know,

"...or they were on better soil or they suffered less compaction or any one of a myriad of possibilities, or indeed perhaps the saplings did grow as well on the central area as at the edges. We just don't know...", because there's no post-planting information on those sites that's presented in the Nicks report.

"We also know nothing from this contribution about impact of clearcut size. Only two sites in two different areas were examined rather than the large number of scaled sizes."

So both of these cuts were about the same size and we take it at its face value. They indicate that trees were growing as well in the middle of the cut as at the side, maybe slightly better, but as well anyhow.

But what can we conclude from that? It seemed to be an attempt to deal with the problems of microclimate but it doesn't measure microclimate, it doesn't do anything except tell us how trees were growing five and seven years afterwards on site.

So it's very limited in what it can help us with, and if we want to ask some questions about the effects of microclimate -- sorry, about the effects of clearcuts on microclimates or even the question of effects of clearcuts on ability for natural regeneration to take place, et cetera, then this doesn't help us.

Q. Now, Dr. Hutchinson, the purpose of the study as expressed in the first paragraph of the study indicates, and I will just read it:

> "In the fall of 1988 E.B. Eddy Forest Products of Espanola and Canadian Pacific Forest Products of Thunder Bay undertook surveys to determine if clearcut size affects frequency and growth of jack pine regeneration."

My question is: What methodology, in your opinion, would be required in order to obtain a scientifically credible answer to the question of whether clearcut size affects the frequency and growth of jack pine regeneration?

A. Well, you would have to -- unfortunately, you would have to sort your objective out into something that you could actually then address - it's a diffuse objective - and then what they

have done addresses just one little component of the objective they have set out to do.

It doesn't say, for example, whether they're trying to look at natural regeneration or whether you can successfully replant clearcuts. They're looking at whether you can successfully -- or they're looking at one component of whether you can successfully replant clearcuts.

If you want to find out the effects of clearcut size on natural regeneration, or indeed if you want to look at effect of clearcut size, then you have to have different sizes, you can't have all the same size and say it's an effective size.

So you would have to have a series of different sizes, and you would have to then try and make sure that at least one set was on the same soil type, and you might want to examine if clearcut size on different soil types has an effect, you would need several soil types.

But to ask if clearcut size affects frequency and growth of jack pine regeneration and then have two stands of almost the same size with one seeded with seven-year-olds and the other one planted with five-year-olds, I mean that's apples and oranges.

Q. All right.

MR. MARTEL: What can you take though from the fact that the trees that were brought in I think as evidence --

MS. SWENARCHUK: That was not from this study.

MR. MARTEL: Was that not from the study? Pardon me.

MS. SWENARCHUK: No, it was not.

MR. MARTEL: Okay. Let me go back to this one then, forgetting that.

MR. CASSIDY: I thought it was.

MR. FREIDIN: Sure it was.

MR. CASSIDY: The evidence as we understand it was that it was, Mr. Martel.

MR. MARTEL: Yes. I am going back to -- I thought they brought in some tree samples for us to look at with respect to--

MR. CASSIDY: That it came from those studies.

MR. MARTEL: --the areas that had been regenerated in this study I think.

MR. CASSIDY: Yes.

MS. SWENARCHUK: No. My recollection is otherwise and --

MR. CASSIDY: We better go back and check

the transcript then--

MS. SWENARCHUK: Yes.

MR. CASSIDY: --because it's my understanding that it was.

THE WITNESS: Well, can't we just pretend for the moment that it was from these sites.

MR. MARTEL: Sure.

MS. SWENARCHUK: All right.

THE WITNESS: And then we can answer the question.

MS. SWENARCHUK: All right. Assuming for the moment -- my recollection really is otherwise, Mr. Martel, however, we certainly will check the transcript and perhaps come back to that question.

However, I think Dr. Hutchinson is prepared to make the assumption that you want, so please proceed to put the question to him that you want.

MR. MARTEL: What can it lead to, the fact that - and I mean this is all ancient history now it's so long ago that this was presented - what can you take from the fact though that the trees were that much greater, let us say they are two different sizes; one is significantly greater than the other, what conclusions can be drawn from the effects of the

clearcut and how the trees respond, whether naturally or planted?

MS. SWENARCHUK: I think, Mr. Martel, perhaps in fairness to the witness, we should explain. He wasn't here to see the trees. I think that at a certain point in the hearing, Dr. Hutchinson - and everyone is free to add if I my characterization is not correct - industry witnesses produced for the Board two trees, one of which was considerably larger than the other, and I'll stop there.

But I think Mr. Martel's question is this - and please correct me if I'm wrong - I think what Mr. Martel wants to ask you is: If a witness were able to provide to the Board two trees from these clearcuts, one of which was significantly larger than the other--

A. Right.

Q. --would that tell you anything about the impacts of clearcut size.

MADAM CHAIR: I don't think that was the comparison. The comparison was a planted versus a naturally regenerated stand.

MS. SWENARCHUK: Fine.

THE WITNESS: So one of them was the seeded in seven-year-old; was it?

MADAM CHAIR: Planted.

MS. SWENARCHUK: Assuming for the moment --

THE WITNESS: And other one was the five-year-old planted and the five-year-old planted was bigger; was it?

MADAM CHAIR: It was bigger diameter and a larger stem.

THE WITNESS: Well, since it says somewhere in this report that within site there's a fair amount of variability, I mean from two trees I would need to be convinced -- you know, if it was going to be a bit suspicious, you need to be convinced that those are representative of a large population of trees.

I mean, we can go into any forest and pick a little one and a big one and we'll pick it up at the same edge or different edges, you can draw no conclusion from that unless you are convinced that that is a truly representative sample of the general population of what's gone on.

So since I wasn't here, you know, I couldn't say much more than that about it. I mean, if the question is: Can you grow trees on clearcuts, I mean the obvious answer is yes; but in terms of telling

us anything about the effects of clearcut sizes, this really doesn't help us.

MADAM CHAIR: Would you like to take a break now, Ms. Swenarchuk?

MS. SWENARCHUK: Yes. Perhaps just one last question.

MADAM CHAIR: Mm-hmm.

MS. SWENARCHUK: Q. Just going back to my question, Dr. Hutchinson, I would just like the Board to be assisted by you using a little more detail.

What would be the methodology and the scale of study that would have to be done to establish whether clearcut size affects frequency and growth of jack pine regeneration?

What are all the parameters that you would want to study?

A. Well, if it means frequency of growth, I presume --

Q. Frequency and growth is what this --

A. Presumably this means natural regeneration; does it, or do you want me to speculate about natural regeneration or not?

Q. Let's consider artificial regeneration first and then natural regeneration. Let's look at artificial regeneration first, okay.

Now, what would the methodology be, what would be the variables that would have to be studied to arrive at a credible result on that issue, artificial regeneration.

A. Well, it would be a substantial study. Certainly you would want to look at a range of sizes of clearcuts. As a matter of fact they have done this sort of thing in Brazil in which they have got clearcuts made to, I think from 5 hectares up to an astonishing 2,000 hectares or maybe even 10,000 hectares -- and I say astonishing, I used to think it was astonishing, but it turns out we have clearcuts of that magnitude now in Ontario.

So you need a range of sizes, you need to know something post -- sorry pre, you need to know your soil types and what your microclimates are, so you need a lot of measurements, micrometeorological measurements, you need to measure soil temperatures, moisture, light, nutritional status, you need to be sure that you're dealing with what I might call a level playing field and that it's a fair test to start with, and that's quite an investment of time and money to do that.

Then you've got your clearcuts of different sizes, and you would also be a little bit

worried about whether you might have some freak event, so you'd preferrably have some replication. So we're getting into something quite big.

The replication, three is the least you can ever get away with for statistical purposes.

Q. Three of each site type; is that what you're suggesting?

A. Mm-hmm. And that only gives you -- that would allow you to look at one soil type or one site.

Then you would want to know how -- you would want to know -- well, it depends on how you phrase the question. I'm not used to trying to come up with scientific tests for this kind of open-ended things.

I mean, do you want to know how do they survive for five years, is it going to be successful regeneration for the next harvest, so that you want to find out how they are at 25 years, 50 years and so on. It's a long-term study, it's an expensive study.

There are other ways that you could go after it, I don't know that we should get into now, but there are other ways we could go after this from some of the cuts that already exist, but you would have to do an awful lot of work, and I don't think this

adequately addresses the questions they were hoping to answer from it.

Q. Now, I phrased my question initially in terms of how would you study the effects of artificial regeneration. Would the scale of study or the factors be different if you were looking at natural regeneration related to clearcut size?

A. Well, it definitely would. If you are dealing with something, say like black spruce or jack pine, then you have got to look at seed sources and, you know, with the best wind in the world that seeds can own travel a certain distance on average. So that basically the larger the cuts, at least if it -- particularly if we deal with the square cut, the further away they are from the standing trees the less likely they are in the immediate future to have seed sources available.

So the bigger they are the less probability we have of natural revegetation taking place even across a stand, you will have an edge effect, and in terms of microclimate, the edge effect is quite steep. A 5 hectare or 50 hectare or 500 hectare clearcut will have about the same micrometeorological conditions at the centre of it as the consequence of taking the canopy out.

The edge effect will be about one and a half tree lengths, maybe a little bit more from the edge, so you will have a very steep change in microclimate from the forest itself coming out and then you hit the level playing field with a substantially changed microclimate.

And I think there's a lot of confusion in the literature and in the arguments that take place as to whether clearcuts of different sizes have different effects on microclimate. I mean, let me just make a basic observation on that. Once you have passed a rather small size in terms of clearcuts you are into a large microclimate change which is pretty well maintained no matter how big the clearcuts get, so...

Now, there are some influences of wind which will depend on size of cut and fetch and things like this which is a bit like lake size.

Q. Fetch?

A. Fetch. Well, you know, the wind blowing across an open area, the distance it blows across is the fetch.

Q. Does the shape of the clearcut have an effect on the --

A. Well, in terms of natural regeneration particularly it would do because the more

you get away from a square towards a rectangle the more you squash things up, the more edge you create, and the closer that some of those -- the centre of it will be to the edge, okay, so the more probable you are to get natural regeneration taking place.

Q. So that would be -- would that then be one of the elements that you would study if you were to be replying to my question of studying regeneration related to clearcut size for natural regeneration?

A. Right. Now, I should also say, before I mislead everybody, of course there is seed sources in the ground and there is cones that would be left from the clearcutting operation, so it's not all dependent on the seed coming in from the edge. But the bigger the cut the less likely you are simply to have seeds coming in from the edge; that is, that the seed rain will be limited to the distance of maybe two tree heights from the edge, something of that order.

Q. And again these are all issues that we had planned to discuss later, but while we're on the subject, with regard to seed sources left on site, is there a difference between the amount of seed source left in conventional as opposed to full-tree harvest?

A. Well, if you're deliberately chopping your canopy off and leaving it on site that will put

your cones and things into your site. If you're taking all of that off site - now some of them will fall off of course, and the more you manage to knock off the better on the way out - but you will be substantially decreasing your seed stock on site.

Coffee?

MADAM CHAIR: Good idea, Dr. Hutchinson. Will you be most of this afternoon,Ms. Swenarchuk?

MS. SWENARCHUK: It's looking like it, perhaps even all of the afternoon perhaps.

MADAM CHAIR: All right. Fine, thank you.

MR. CASSIDY: I might advise, Madam Chair, that I left a message for Mr. Hanna at his home/office last night, did not get a return answer and I was advised at nine o'clock by Mr. Pascoe that he was having similar blackout success with respect to Mr. Hanna.

In light of what Ms. Swenarchuk has just advised it may be academic, but I just pass that information on to you.

MADAM CHAIR: All right, thank you. The Board will be back in 20 minutes.

---Recess taken at 10:30 a.m.

---On resuming at 10:55 a.m.

MADAM CHAIR: Please be he seated.

MR. CASSIDY: Madam Chair?

MADAM CHAIR: Mr. Cassidy?

MR. CASSIDY: Yes. Thank you, Madam Chair, Mr. Martel. We have had the opportunity - and I want to thank Mr. Pascoe for making the transcript so readily available. We've had the opportunity to review the transcript with respect to where those trees came from that you and I were thinking about and you may have been operating under the same confusion I was that they came from the Nicks study which came from the case study that Mr. Nicks was referring to. Those are two separate plots of ground and the trees came from the case study blocks B and C.

And that for your reference can be found in Volume 199 of the transcript for May 8th, 1990 at page 35182.

MR. MARTEL: 35...?

MR. CASSIDY: 35,182, actually 181 and 182.

MS. SWENARCHUK: So then, just to be clear, Mr. Cassidy, the trees that were from the case studies were not from the plots in the Nicks report that we were just discussing this morning?

MR. CASSIDY: That's what I just

indicated, Mr. Martel.

MADAM CHAIR: So the comparison had nothing to do with clearcut size but rather planting versus natural regenerated stems?

MR. CASSIDY: That's right.

MADAM CHAIR: In the case study, right.

MR. CASSIDY: In the case study blocks B and C which is referenced on that page.

MS. SWENARCHUK: Madam Chair, Mr. Martel, we want to turn now to evidence regarding a comparison of the effects of natural disturbance, particularly fire, and the effects of clearcutting in summary form, but just before we do that, I want to refer Dr. Hutchinson to some evidence that has been led with regard to amount of loss due to blowdown and insect infestation. And again we are looking at two exhibits which I don't think we need but also at Volume 74 of the transcript.

Q. Which you have, Dr. Hutchinson, I believe.

A. Mm-hmm.

MADAM CHAIR: What were the page numbers in the witness statement, please?

MS. SWENARCHUK: In the witness statement, we are now looking at witness statement 1A.

Q. And the first issue that I'll ask Dr. Hutchinson to address with regard to comparing effects of natural disturbance and human disturbance is the issue of the size of disturbance.

And I would like to turn in transcript Volume 74 to page 12538, and this was in Mr. Cosman's cross-examination of Dr. Armson, and on this page of the transcript we see Mr. Cosman's reference to Exhibit, I believe, 421 and to the size of area damaged in spruce budworm infestation, and at the top of page 12538 Dr. Armson, I believe reading from that exhibit, indicates that the exhibit indicates:

> "It specifically identifies 448,637 hectares of new mortality in the northwestern and north central regions, so that the total recorded for the current outbreak is 14.5-million approximately hectares."

Then reading down the page, beginning at about line 16, he's quoting from the exhibit:

> "In Sudbury District the average mortality at five locations increased from 4.6 per cent in 1987 to 14.6 per cent in 1988 and the number of trees with bare tops increased from 4.6 to 9.6

percentage at the same location."

It then identifies:

"Increases also occurred under similar circumstances in Espanola District where records in four mortality plots showed an increase in average mortality from 14.3 to 16.8 per cent and increase in bare tops from 12.8 to 20 per cent."

Now, Dr. Hutchinson, taking this for example as an indication of sizes of area of forest which suffer damage from spruce budworm, do the sizes referred to in the exhibit, in your view, indicate that large size clearcuts are ecologically acceptable?

Let me put the question another way: Is there a difference, in your view, between the effects of insect infestation and the effects of clearcutting on the land base?

A. Are you saying there's a very large area which has been affected by spruce budworm -- this is spruce budworm; was it?

Q. Yes.

A. And can you conclude from this that we could also therefore have large clearcuts, is that what your --

Q. Thank you, that's the question.

A. Well, I don't think there's any relationship between the two. I mean, the decisions on clearcuts are totally different decisions. The mortality -- I mean, we're talking about a disaster here; are we not, we are not talking about spruce budworm disaster, I don't think we should, therefore, suggest we should have clearcuts, I don't think, in the same direction.

Clearcutting removes nutrients from site as we have sort of gone through at length, and if we did nothing with the spruce budworm damage but leave the trees that are rot on site, then there will be nutrient renewal, so it's different in that sense.

If we get in quickly after spruce budworm damage and do some harvesting, then it would be obviously much more like a clearcut, but that you would be clearcutting. So, you know, if you're clearcutting spruce budworm damaged area, then it's like a clearcut, it would be a little bit different because of foliage loss and so on.

But in the spruce budworm damaged areas, just reading this here, it seems that all of the trees are not affected anyhow, it's obviously spotty, and it's a mosaic of patches.

It's substantial damage, but bare top is

increasing from 4.6 to 9.6 in the Sudbury District at five locations, for example. That's totally different than clearcutting, where we're talking about a hundred per cent removal, almost a hundred per cent.

Q. So you identified a difference in nutrient implications between spruce budworm infestation and clearcutting effects. Are there any other differences between the two that you would want to enumerate?

A. Well, I mean, I don't think spruce budworm is a terrific thing to have going through your forest. This is something that's a very unfortunate situation. We've got several other insect pests which cause devastations, you know, either historically or in some cases many people believe increasingly, and that's a particularly unfortunate situation.

I don't think we can make any parallels between what's occurring with spruce budworm either in terms of effects or in terms of size or acceptability and clearcutting. I see no parallel.

You've got to do mental acrobatics to get from, you know, a very unacceptable spruce budworm situation and sizes of clearcuts. I do believe that size of clearcut is a very important ecological issue, but it's equally as important as insect damage.

Q. All right. The next subject area that Mr. Cosman discussed with Dr. Armson, which occurs beginning at page 12539 of the transcript, had to do with blowdown or wind damage. And the question was -- the witness was turned to page 26 of the exhibit and the following quote was read:

> "In all some 26,426 hectares of damage - this is from wind damage - were mapped in the Red Lake, Dryden, Sioux Lookout, Ignace, Fort Frances and Thunder Bay Districts."
>
> And then goes on to mention that:
>
> "Since then additional areas of wind damage, probably resulting from the same storms that caused the damage above, were mapped in the north central and northwestern regions, bringing the total area of damage in the two regions to 32,811 hectares."

Now, first of all, Dr. Hutchinson, to your knowledge, are large blowdowns common in the boreal forest, large areas of blowdown?

A. No, they are not, I don't think they are common. These are quoted because these are rather extreme events.

Q. And could you indicate whether, in your view, there is a difference in the effects of blowdown of forest as compared to the effects of clearcutting?

A. Well, clearcutting removes almost all of the trees from site and the trees are obviously, therefore, dead and they are not available for future seed sources. Blowdown certainly doesn't kill most of the trees, the majority of them, it creates a shambles of a forest and certainly some of them are killed, but a lot of them are not and they attempt to regrow from where they find themselves perched and it's a patchy thing, blowdown.

So you would have a lot of seed source, you would have a rather messy forest - go back to the aesthetics again - you have a forest that's certainly not desirable from many points of view, but you have a lot of, a high percentage of living trees in it with a seed source and the nutrients are on site. So if we look at it from the nutrient point of view, there is a very substantial difference between a blowdown situation and a clearcut situation.

Q. And just to summarize again, with regard to seed availability what is the difference between the two?

A. With blowdown you've got seed available still on site and you've got all kinds of gaps created and microhabitats and exposure of mineral soils and so on which create new seedbeds.

Now, of course we do go into blowdown areas and try to harvest, you know, to change the circumstances.

Q. Now, with regard to blowdown or windthrow, I would like you to look at Exhibit 1121, which is Industry's Panel 6, and particularly with regard to Dr. Methven's evidence.

A. Okay. Do you want to -- I have it. Okay. I'm happy just for you to read it out.

Q. I think you will need it, in fairness.

A. Ten? What panel is it?

Q. 6.

A. Is it this one?

Q. Now, for the Board's assistance, Dr. Methven referred to the question of blowdown on page 48 in the last paragraph and provided some examples of sizes.

Then if we can look at page 51 of the witness statement and the last paragraph, Dr. Methven was discussing silvicultural systems; the selection,

shelterwood, seed tree, clearcut methods of cutting, and the seventh line from the bottom he said:

"Thus, the reproduction methods represent a continuum of opening sizes and distributions from .1 hectare to thousands of hectares depending upon the precise management objectives in terms of the species to be favored and economic realities. No part of the continuum is any more ecologically valid than another since it can represent the blowdown of a single tree to a 300,000 hectare fire."

Now, do you have a comment on that sentence, Dr. Hutchinson?

A. On whether...?

Q. Do you agree that no part of the continuum is any more ecologically valid than another since it can represent the blowdown of a single tree to a 300,000 hectare fire?

A. Well, I think one reasonable ecological way of looking at it would be the frequency or the probability of the event occurring, and I think we generally feel that extreme events are not ones that we would consider to be, by definition, normal.

And, therefore, we might be more

interested in what the normal gap size is or the most frequent gap size which occurs in the forests, if we're going to intend to simulate natural situations. Now, that's not to say that, you know, these extreme events don't occur but, by definition, they are very rare and--

MADAM CHAIR: Excuse me, Dr. Hutchinson. They are rare, you're saying, by their large size but they're not rare by frequency?

THE WITNESS: No, no.

MADAM CHAIR: You might have very many small fires, you might have many small --

THE WITNESS: Oh, absolutely, yes, and many blowdowns too, yes.

MADAM CHAIR: So in that sense they're not abnormal, that's a normal part of the forest?

THE WITNESS: Mm-hmm. So you might want to -- if you're going to talk ecologically, that is, we're going to try and do something that simulates natural processes and the components of the natural processes, then small blowdowns and small fires would be the most appropriate way of doing them. Very large ones would be extreme events.

MS. SWENARCHUK: Q. And what, in your view, is the most common gap size that occurs naturally

in the forest?

A. Well, the most common size is one tree could blow down and that is true both in the hardwoods and in the boreal system. It doesn't normally create much excitement, one tree blowing down, but that's the normal gap size that's created.

Q. Now, just with regard to your discussion of extremes and the reference here to a 300,000 hectare fire - and we will come to fire size in general in a moment - but just departing from this reference--

A. I'm sorry, what page are you on?

Q. We're at the bottom still of page 51.

A. Oh, okay. All right.

Q. Is it your view that regeneration of conifer after a 300,000 hectare fire -- well, let me ask you: Would you expect good softwood regeneration after a fire of that size?

A. Good softwood regeneration after a fire of 300 hectares?

Q. Thousand hectares.

A. 300,000 hectares. Well, that would be -- it would depend on fire intensity. It would be very patchy regeneration, but a fire of that size would I think create some significant problems in terms of

regeneration, but it's really a question of intensity and, you know, the mosaic that's left behind and amount of organic matter that's left behind and things of this kind that is important.

It occurs to me - I'm just looking at this last sentence - no part of the continuum is any more ecologically valid than another since it can represent a blowdown of a single tree to.." The probability of a blowdown of a single tree in a particular area in any one year is very much higher than that particular area being consumed as part of a 300,000 hectare fire.

It would be like saying, if we want to be ecologically valid in terms of the, again say the Canadian population, it would be difficult to argue that a person of 5' 8" is as representative as one 7' 6" in the population or 10' - which maybe has occurred, I don't know. We are talking about extremes here.

Q. Can we look now at the question of comparison of the effects of fire to the effects of clearcutting, Dr. Hutchinson. And this is, as you said, an issue that you addressed in Panel 1A of your evidence.

And, first of all, would you address yourself to the question of comparisons of size of

fires and sizes of clearcuts.

A. Can you focus that question a bit more?

Q. Well, can you assist the Board with the question of average sizes of fires in the boreal forest of Ontario?

A. And then average sizes of clearcuts. I would be struggling on the second.

Q. We will take care of that later, thank you. But for the moment, if you would--

A. Okay.

Q. --consider the question of size of fires. You have considered it to some extent in Panel 1A and I understand that you have a summary document as well which you would like to...

A. Right. Now, that was in response to one of the interrogatories, so that I thought it might be useful if we actually looked at the sizes of fires which have occurred since records begun in 1917 in Ontario.

MR. HUFF: (handed)

MS. SWENARCHUK: And the exhibit number, Madam Chair?

MADAM CHAIR: 1412. Did you say this is part of an interrogatory response?

THE WITNESS: This is how I was led to go and get hold of this.

Do you want me to take you through this?

MS. SWENARCHUK: Yes, would you please.

THE WITNESS: Okay.

MADAM CHAIR: Excuse me, Dr. Hutchinson. Just for the record, why don't we identify what Exhibit 1412 is. It's a two-page excerpt, pages 76 and 77, of a publication by the Ministry of Natural Resources called Statistics 1987-1988 and the table is titled: Forest Fire Record.

---EXHIBIT NO. 1412: Two-page excerpt (pps 76 and 77) of MNR publication called Statistics 1987-1988 and table titled: Forest Fire Record.

THE WITNESS: In fact, for those interested in fires it's a fascinating document. It gives us the fire record for the province from 1917, when the Ministry of Natural Resources apparently initiated it's record-keeping, to 1987. So it's a 70-year record of fires.

And what it does, or our interest here would be in the area burned, the total hectares burned, the number of fires which occurred each year which were reported and identified, and then the question that you are asking me, Ms. Swenarchuk, was about the average

size of fires per year, and that is all nicely listed here.

And perhaps in interpreting this we should realize in the early days, say 1917, the early fires were not fully recorded and reported, so the inaccuracy might have been greater then than it would be at present, and also of course we didn't have the fire prevention policies in place which we have now.

But if you look down the number of fires which occur per year in the province the variability is really, really rather low. I'm sort of surprised by the variable. So the number of fires is turning out to be about 1,200 fires per year in the province.

The size of them of course varies quite a lot. Even with our fire prevention policies in place you will see that during the -- when we go from total acreages or hectareages burned of a high in 1923, that was actually the worst year ever of 857,000 hectares burned by 1,343 fires, and that gave us an average fire size of 639 hectares.

Now, we've never had anything as bad as that in the subsequent 70 years. So 640 for an average size that year and as usual, of course, you have quite a skewed distribution; that is, you would have a small number of very large fires and a very large number of

small fires. That's basically the pattern as it goes.

Once we -- and we have many years during the 20s, 30s and 40s in which the average size of fire is in the 30 to 40, sometimes as low as 20, or even 4 hectares per fire per year. So the average fire is coming out to be really quite small in size. That's the average area. And that of course is loaded in the direction of large size by those very large events which do occur. So if you took -- instead of taking the average, if you looked at the main I think you would come out with even a lower number. That is not terribly important.

The other thing is that it looked like we had got the sort of fire acreage in hand until we get into the 1970s and then, despite all of the policies in place, we have this surprising rather large number of events of substantial, more than half a million hectares burned per year on quite a number of occasions, or over 400,000. And the general feeling is that this reflects particular climatic changes which were occurring in that period and that has really continued up to the present.

If we want to be bloody minded about it we can say: Well, really we should go with the average size of a fire for the 1985 for clearcuts, that's one

hectare. If we take the average for the last 10 years in that record - I actually calculated that for you - the last 10 years, which includes a few fairly large years, that's 90.4 hectares is the average size of fires in the province for the last 10 years.

The average size for the last 20 years is 73.7, and the average size for the last 25 years - if that is of any interest - is 67 - quarter of a millenium - is 67.4 hectares. But the point is that most fires are small in terms of the -- and that the very big fires we get on rare occasions account for quite a large high percentage of the total acreage burned.

So if you want to have any, you know, any relationship to natural events, the way we should look at it, I suggest, is that we should perhaps be simulating natural treefall or simulating natural acreages burned and the average is, as I say, for 25 years about 67.2 hectares.

It's surprising to me, I mean this is not necessarily totally relevant, but it is surprising to me that we've had such an upturn in fire acreage, and you can see in a year like 1976 there's nearly 4,000 fires, and that this pattern has been repeated across other parts of Canada, that fire frequency has

increased. And, as I say, the explanation - no proof - but the general feeling is that increased drought periods and hot summers have been factors.

Q. Now, would you turn again please to Dr. Methven's witness statement, Dr. Hutchinson, at page 45 and 46, and this is Exhibit 1121.

A. Yes.

Q. At the middle of page 45 Dr. Methven has quoted Hienselman, this is the second full paragraph on the page, the quote from Hienselman:

"The pre-settlement forests of much of northern North America were strongly fire-dependent and if we are to understand the dynamics of most forest's ecosystems we must first understand fire's many roles."

Then turning to the next page and the first full paragraph on page 46, the seventh line reads -- well, I'll start earlier, the fourth line -- it's going to be the whole paragraph.

"A corollary of the adaptation to disturbance is that ecosystems in disturbance-prone environments are not fragile but have developed resilience where resilience is a property that

allows a system to absorb and utilize or even benefit from change. This is particularly true in Ontario where the forest is continually rejuvenated as a result of death and renewal is driven by relatively large scale and often intense events such as fire. Thus, mortality and renewal take place not at the scale of the individual but at the scale of the community and the landscape; not at the scale of fractions of a hectare, but at the scale of tens and hundreds of thousands of hectares."

Do you agree with that paragraph, Dr. Hutchinson?

A. Well, I agree with little bits of it, but I don't agree with the conclusions that are derived at the end, that mortality and renewal take place not at the scale of the individual but at the scale of the community.

Mortality takes place at the scale of the individual and there are occasions when you have a lot of individuals involved and then it's, you know, you're increasing the scale of it, but mortality takes place at the level of the individual.

It would be astonishing if mortality took place at the level of the community, and I don't know what the scale of the landscape actually means, but maybe that means bigger than the community.

So this mortality and renewal would normally be taking place on a much smaller scale than the suggestion of tens and hundreds of thousands of hectares. I mean, hundreds of thousands of hectares would be some absolute major catastrophic event and that would be, by definition, astonishingly rare.

In terms of resilience, I mean I think we should recognize that obviously plant and animal systems do have some resilience and that ones which experience fire on a regular basis are likely to be adapted -- by definition, they have to be adapted to cope with the consequences of fire, either by fire avoidance or by fire survival. So you have this success of species some of which come in after fire and some of which survive through the fire.

You can't go from that to say that because this system is fire adapted and fire resilient, therefore, it's resilient to any other kind of stress you wish to impose on the system because, you know, it just wouldn't follow that that would be the case.

Now, there may be some parallels between

those species which can survive fire in certain other circumstances, but then you have to examine how close those circumstances would be to fire itself.

Q. Now, having looked at the size question related to effects of fire and potentially the effects of clearcuts, would you now indicate for the Board any difference between fire, the effects of fires and the effects of clearcuts with regard to the impacts on the forest floor?

A. On the forest floor, okay. Well, if we start with the closer similarity it would be removal of canopy.

Q. Excuse me, if it's of assistance to you, I'm referring now to a section of your witness statement beginning at page 5 of Panel 1A evidence.

A. Well, there are a lot of differences and I think it's important that we - I don't suppose we would even get much argument about it - there is a lot of differences between fires and clearcuts.

With clearcuts you're moving, especially the present full-tree harvesting, we're removing a very substantial portion of the material off the site and out of the boreal forest.

With fire certainly you have some nutritional losses and you have some nutritional losses

from the site both in the smoke and in terms of run-off from the system so -- but those losses will be much less than clearcutting, full-tree harvesting and removal.

If you take a sort of a broader view of the boreal forest, much of the particulate and smoke material that leaves --

Q. Would you like a break, Dr. Hutchinson?

A. No, I think I'm okay. I just have to clear my throat.

If you determine where the smoke falls out, I think I would be quite safe in saying that most of the smoke generated from boreal forest fires falls back in the boreal forest. Now, it won't necessarily fall back in, but I think in time you can say that what's coming down on average will average out and you will have much of the nutrient material lost in the form of particulate matter, smoke and ash and so on, will finish up back in the boreal forest.

There will be a high percentage which actually stays on site. There will be instant oxidation of a lot of your nutrients which are tied up in either the living biomass or the forest floor. I think - to quote I think some of Dr. Armson's work - I

think about 50 per cent of the organic mass on average is left behind.

If you can think of an average fire - and it's very difficult - but on average we finish up with quite a significant portion of organic matter still left on the site from the forest floor example.

Now, if you've got intense fires, slow burning fires and so on, that will be reduced to a low percentage, but if we try and look at it all from the studies that Dr. Armson carried out, it seemed that there was very frequently quite a bit of organic matter still left there, and there would be gaps down to the mineral soils. These provide useful seedbeds for a number of the boreal forest tree species as well as for some of the ground flora species.

The sudden oxidation means you have an immediately available, for the first time in some cases, sort of adequate supply of things like potassium, calcium, magnesium and the fire itself -- I mean through the atmosphere the major losses would be of nitrogen and potassium and some phosphorus, it will go up in the smoke, some of it's volatilized and vaporized and, of course, the sulfur goes up as sulfur dioxide and some of the carbons as carbon dioxide and so on.

That gaseous material will travel much further, but the particulate matter which contains quite a lot of important elements will come down within some distance, within some reasonable distance, within a hundred kilometres of the fire.

Now, there have been a number of studies which look at this - I quote one there - looking at the rain quality downwind of a fire and upwind of a fire or before and after, and it really emphasizes - that's from Kimmins book - I believe it emphasizes this point that material is returned to the ground.

Q. I take it -- and this is the section of your witness statement on the effect of fire on nutrient status of forest, and that's from page 10 and following; is that correct?

A. And some of the other --

Q. Can we go back to the effect on the forest floor. Could you just summarize briefly how fire affects the forest floor?

A. Well, it obviously burns and kills quite a lot of material. It will have the effect of killing the root systems if it burns into the forest floor to any depth. Some of the shallower rooted herbacious species, it's likely to be pretty devastating to some of the ground floor lichens and

some of the feather mosses.

This means that survival after fire, depending on the intensity and all these other qualifiers, depends on somewhat deeper -- the temperature gradient into the soil in a fire is quite steep. By the time you get down a few centimetres you have a substantial drop in temperature. By the time you get down, say, 25 centimetres you have a very substantial drop in temperature.

So you may not generate a killing temperature some distance down in the soil. This allows some root systems which have the capacity to regenerate to survive through the fire, so you will get certain species which have deeper roots - stolons, corms and things - which will come back after fire.

But in a clearcut you would actually have a good deal more of these root systems which were still alive and that, in a sense, leads to one of the problems that we face in regenerating the sites after clearcuts; that is, that there's a tendency to get a lot of broad leafed shrubs and trees which you're not wanting to come up rapidly after fire exploiting, if you like, the sudden nutrient availability.

Q. After fire or after clearcutting?

A. Sorry, after clearcutting.

Q. Now, in your witness statement you indicate on page 5 about six lines from the bottom:

"In most rather fast moving summer and spring fires the patchiness of the burn is striking."

Now, what are the implications of that for effects on the forest floor?

A. Well, if you walk through, you know, any post-fire site you will find that there's a significant amount of material above ground which has survived the fire and the patchiness depends on wind directions and fuel loads and moisture contents of the ground and low lying wet areas and so on. So there's potential material for reseeding after fire which is always left there, some in situ; that is, on the spot.

And in clearcutting, of course, the purpose is to remove your marketable timber from site, so you're tending to do a much more even removal job on it, removing the tree seed sources from the site. And, of course, you're also levelling things -- apart from leaving slash there, you're levelling things to a much greater extent with clearcutting than you are with a fire.

In any -- you just find stumps and full-length trees with the canopies burned off and

things in fires, and this provides some shade as the sun moves around, you have some creation of microhabitats which I think many people feel are important in the regeneration process after fire. Now, we don't get that to nearly the same extent with clearcuts.

Q. In the second paragraph on page 6 of your witness statement you indicate:

"Much less well known is the important role in nutrient cycling of some of the lower plants which often cover a very large percentage of the forest floor in mature pine and spruce forests."

Would you like to make a summary comment on that?

A. I just have to read what I wrote.

MADAM CHAIR: Are we back on page 6, Ms. Swenarchuk?

MS. SWENARCHUK: That's correct, 6 to 7.

THE WITNESS: Yes, we're on the last paragraph.

Okay. Well, what I'm saying here is that these feather mosses which cover a high percentage of the ground of the boreal forest in fact play an important role in that whole forest's nutrition, and

there has been a number of different studies and I have quoted the Timmer study there, but there are various other studies which have shown the same sort of thing. And incidentally, these feather mosses and ground lichens are pretty good indicators of forest combination, so obviously they reflect them.

Now, a number of species don't germinate, don't establish particularly well in a a dense feather moss mat or in a sphagnum mat which would be a different circumstance.

Fire, as I've indicated, doesn't -- on average it's burning down about 50 per cent of the organic mat. This means that you have got a kind of mineralized layer on top, it's black, and that's incidentally, I should have mentioned, the albedo effects of fire.

Obviously, fire provides a black surface and clearcut doesn't necessarily do that, the feather mosses die out, you know, over the first year or two after clearcut, if there is no major ground disturbances, simply desiccated away; in fire most of them are killed with the burn themselves. So these are the differences.

The creation of the burnt parts of the organic mat provides a good seedbed for some of these

tree species and some of the species which don't establish very well into the feather moss itself. They take quite a while -- the other point I'm making is that some of these things take quite a while to get back in, except that study of Ahlgren done in Newfoundland, it has taken the -- one of the key reindeer or caribou lichen, it has taken it about 60 to 80 years to get back in after fire, and they are an important nutrient source, they are reservoir of nutrients.

Q. All right. The next section of your witness statement has to do with post-fire succession and I would like you to summarize that section, particularly with comparison of these effects to the effects of clearcutting?

A. Well, if we deliberately establish a forest after a clearcut then we have decided in advance what the species composition is going to be, so that is going to be clearly different than if we are going to allow natural revegetation to take place.

After a fire there's a sequence of events. Within about -- well, certainly within two years you will get a good deal of the ground tended to be covered again and these species will be picking up quite a lot of the nutrients that are available, so the

quicker you get revegetation the better onto a site, frankly whether it's a clearcut or a fire, in terms of retention of nutrients and availability to maintain the system. So, I mean, as sort of an aside here.

It follows from that that it would be a very good thing if we could get onto sites quickly after clearcutting and do our planting and revegetating or accelerated natural revegetation within a year or two, because that's when the system is leaky, most leaky.

In terms of succession which takes place, obviously if it's a jack pine system it's the opening of the cones - and I'm sure you people must have been through all of this before, I don't think you want to jump back to jack pine and black spruce today - but there is a sequence of events and the jack pine fires -- sorry, the jack pine forest will gradually give way to spruce and hardwood over time if there is not an intervention of a fire.

Now, we mentioned yesterday that you can in fact get some quite ancient jack pines. One of the concepts maybe that's generally around is that they can't live beyond about 150 years, but that turns out by no means to be true, but they can -- individuals can live a good deal longer than that and there is a

gradual changeover in the absence of fire to a different forest community, the maturity in the ground floor and then there's a changeover from species like balsam getting in there which are able to tolerate the shade gradually will emerge through the jack pine.

MS. SWENARCHUK: Madam Chair, I would like to pause here before commencing a new subject after the lunch break, if that is acceptable.

MADAM CHAIR: That's fine, Ms. Swenarchuk.

MS. SEABORN: Madam Chair, in relation to the discussion with the trees, the two trees, blocks B and C, it was my recollection - and I have just reviewed the transcript again - the comparison was not artificial versus natural regeneration, I believe both these sites were planted sites and Mr. Nicks was explaining a difference in aspen overstorey removal was the proper terminology.

I think the Board had said they were looking at artificial versus natural regeneration. We can all go back and look at case study 4B and see what the treatments were, but I just wanted to put on the record that that wasn't my recollection.

MADAM CHAIR: Thank you. My recollection was incorrect then. So you're saying in the transcript

it's talking about spraying versus --

MS. SEABORN: No, I believe -- well, we can go back and see what the actual treatments were, but I believe both blocks B and C were planted sites. I don't believe the trees --

MADAM CHAIR: And one was tended and one wasn't?

MS. SEABORN: I think it was a difference in site preparation, whether there was heavy site preparation or what's called the dip and dive method we heard about. In any event, we can all go back and check that.

MR. CASSIDY: It's in the transcript, Madam Chair.

MS. SWENARCHUK: 1:30 then, Madam Chair?

MADAM CHAIR: Yes.

---Luncheon recess taken at 11:50 p.m.

---On resuming at 1:30 p.m.

MADAM CHAIR: Please be seated.

MS. SWENARCHUK: Q. Just a few short questions in addition to this morning's before moving on to a totally different area.

Dr. Hutchinson, would you turn, please, to Exhibit 1121, Dr. Methven's evidence at page 54, please. And in the second paragraph on that page, the

first complete paragraph, seven lines down we see:

"Thus, in larger fires there are often stringers and islands of surviving trees that may occupy areas within the fire perimeter. These islands and stringers of surviving forest can be important to wildlife in terms of cover. Ecologically, therefore, there is no limit to the size of a clearcut that can be enclosed within a perimeter as long as a minimal amount of cover is retained."

Now, do you agree that ecologically there is no limit to the size of a clearcut that should be permissible?

A. Well, I don't see that that statement follows from the statement above it, I don't see the connection between the two. Limits to the size of clearcuts are one issue, the occurrence of surviving stringers or islands within a fire are quite a different issue. So, what's your question? Was your question do I agree with this?

Q. That was the question.

A. I guess I don't.

Q. And in the next paragraph, the fifth line suggests that:

"Restricting opening size in Ontario's commercial forests is not a question of ecology but of tradeoffs between benefits, values and environmental impacts."

Now, in your view, are there ecological reasons to limit the size of clearcuts?

A. Ecological reasons to limit the size of clearcuts. Yes, I think there are. I'm still contemplating this first thing you read out to me about no limit to the size of a clearcut because in fires islands and stringers occur.

One of the important differences between clearcuts and fires is that in islands -- I mean, sorry, in fires you do get a lot of points for potential innoculation back into the site I suppose; in clearcuts that isn't the case, so that they're actually - I can answer you more clearly now - they're quite different. I don't see how he can say that clearcut doesn't need to be limited because stringers occur in fires. It's apples and oranges again.

Q. And at the top of page 55:

"Smaller cuts require more intense network of roads and the exploitation of a larger area within a given time for a

given volume of wood and represent a scale of disturbance that may not be compatible with the environment in which they occur."

Now, do you agree that small cuts represent a scale of disturbance that may not be compatible with the environment in which they occur?

A. No, small-cuts would be much like the more normal small gaps and small fires which occur. There's a bit inbetween, it's the more intense network of roads which may be the problem.

It may be with some of the equipment that's being used at the moment that really small cuts -- I mean, there's a relationship between the equipment you use and the way you harvest it, so...

Q. I don't want to leave this subject --

MADAM CHAIR: Excuse me, just one moment, Dr. Hutchinson. I don't know if it's clear to me about the last -- what your comment was on the last point. Dr. Methven was talking about smaller clearcuts requiring a larger road network which he suggests has negative impacts on its own.

THE WITNESS: Mm-hmm.

MADAM CHAIR: And are you saying that the benefits of small clearcuts outweigh any negative

impact accruing to building more roads?

THE WITNESS: No, I don't feel I'm in any position to comment on the intensity of the road netword that's required. I certainly do know that in places like Finland they do small cuts on a regular basis and presumably they're not doing it out of economic suicide, so I presume it is quite possible to do it.

So I don't feel I can comment on the intensity. Small cuts in terms of ecology would be much closer to the natural situation than cuts of infinite size which is suggested on the previous page. The road issue is a somewhat separate issue.

MR. MARTEL: How about the last statement though. Can you give an example:

"Thus, the cost of wood will rise appreciably. Erosion from roads and stream crossings is liable to increase and the habitat requirements of other wildlife species may not be met."

What type of wildlife specie requirement wouldn't be met if you didn't have large clearcuts?

MS. SWENARCHUK: Well, Mr. Martel, I don't know that Dr. Hutchinson feels qualified to answer that question or not. We will certainly be

presenting evidence on wildlife issues later. If he feels qualified to answer the question, I'm quite happy that he proceed.

THE WITNESS: He'll be able to judge from my answer whether I'm able to. Okay. So the question is: With any habitat requirements -- do any habitat requirements of wildlife necessitate large cuts?

MR. MARTEL: Yes.

THE WITNESS: No. I think that is a matter of common sense rather than expertise.

MR. MARTEL: Well, but it says the habitat requirements of other wildlife species may not be met.

THE WITNESS: Mm-hmm.

MR. MARTEL: So...

THE WITNESS: Well, I'm struggling to think of wildlife habitats and wildlife species that would be -- if we didn't have clearcuts in the boreal forest we should ask ourselves the question: Would that cause extinction of any species? I don't think so. They've survived pretty well without them until recent time, so I can't imagine...

Now, the argument may be that these will be the replacement for fires, but we have already demonstrated that fires are going on at a pace of more

than a thousand per year now, so there is not a necessity to do a favour to nature by replacing fires by clearcut. So the clearcut issue is entirely to do with the forest industry not survival of species.

MS. SWENARCHUK: Q. Excuse me, one moment. I would like to turn now to a totally different subject, Dr. Hutchinson, and that is the question of impacts on forests of air pollution which you have dealt with briefly in your witness statement on pages 23 to 25.

A. That's right.

Q. And first of all, my question is: Is there any evidence that air pollution has effects on forest health in Canada?

A. Oh yes, there's a great deal of evidence that it affects forest health.

Q. Now, what air pollutants cause the greatest concern?

A. What are the air pollutants in Canada which are causing the greatest concerns or causing the greatest damage to forests? I guess it's the same.

Well, we're moving from a situation in which sulfur dioxide was the gaseous air pollutant of greatest concern because of the damage it was doing to ecosystems and so on, to a situation which probably the

greatest concern is now focusing on ozone and photochemical oxidants.

Q. And what are photochemical oxidants?

A. Okay. Let me just make it -- say one further sentence. Another form of air pollution which doesn't come down in gaseous form is acid precipitation, acid deposition, so there's continuing concerns about the extent and severity of damage, particularly to lake systems but also to forests, from acid precipitation, but in terms of the gaseous pollutants we are left with, or we have moved to a situation in which there's general North American concern about effects of photochemical oxidants.

Now, this is typically called the Los Angeles smog, so this is the smog which is generated particularly from automobile exhaust fumes which liberate hydrogen hydrocarbons from the gasoline combustion and nitrogen oxides from the nitrogen in the air combining the high temperatures with oxygen.

So we have nitrogen oxides and hydrocarbons being emitted and there's lots of other sources, any high temperature combustion process is putting out nitrogen oxides and, of course, refineries and so on or any oil burning is putting out hydrocarbons.

In the presence of sunlight the nitrogen oxide is converted with catalysts in the air and you finish up with ozone and a string of other organic compounds which we call photochemical oxidants.

Now, this takes some time and, in a sense, we've got into regional problems of ozone. That's not to confuse it with the high stratispheric ozone problems which is too little there and too much here, in terms of stratispheric -- stratisphere.

The ozone is generated, photochemical oxidants are generated during the course of the day, generally they require sunlight for this conversion - that's the photochemical bit of it - and they move out from the cities and they will be moving as air masses out into the forests, they will be moving out across Ontario.

And the Ministry of Environment has had monitoring of ozone levels in the province I think since about 1972 and in the States they have had monitoring on an extensive scale since 1964, and the thing is that though we're doing our best in terms of regulations to control photochemical oxidants and ozone, the levels have gradually been increasing.

One of the ways of looking at forest damage that they've used quite extensively in the

States is to compare the growth of forest trees, if they are exposed to filtered air which you deliberately remove the pollutants, and give them,you know, fresh air compared with air which hasn't been filtered, and over many plots in the United States where they've carried out a major survey they've found there's a significant reduction in growth and photosynthesis if they're exposed to unfiltered air to the natural air, and one of the key components has been the ozone.

To try and put this into -- okay. So we also know that in the forests around -- in the mountains and forests around Los Angeles that there has been substantial damage to some of the key tree species there like Ponderosa pine, Jeffery pine. There has been quite a substantial die-off of some of these tree species in the San Bernadino Mountains.

About 15 per cent of the individual trees have been eliminated. They thought for a while the whole lot would be eliminated, there was real concern that these major recreational areas were going to lose all of these beautiful trees, but it turns out there's about 15 per cent of the population which is susceptible, very susceptible and they were eliminated and in a sense it's stabilized now. There has been some changes in the forest communities.

If we look to the east and say: Well, that's a Los Angeles problem, if we start asking questions of forests which relate more directly to the Ontario situation, right through from the Great Smokies - there's a substantial ozone problem there - right through to South Carolina, all the way up across into Quebec we have ozone, photochemical oxidant problems.

There was a real problem of crop damage which goes on to the present in the province from ozone. We had to change our tobacco varieties in the 1950s and 60s, actually because there was a recognition that you can't sell blemished tobacco, and there was a big breeding -- probably smokes just the same, but the buyers don't like blemished tobacco especially for wrapping cigars, so we had a big breeding program that was very successful and they produced ozone resistent to wrap up called the Delhi variety in Canada. We actually managed to sell it in the States and so on.

But that was indicative that we're moving into air pollution episodes and that, therefore, the forests were becoming at risk.

Eastern white pine is about the most, together with Ponderosa pine, is about the most sensitive tree species to ozone damage and of course

ozone damage, as Mr. Martel is aware, white pine is almost remarkably susceptible to sulfur dioxide, so it gets -- it just thought it was recovering from the SO2 insults when it started getting clobbered with ozone damage.

Now, I don't have the figures with me, but in the United States there is deep concern with the U.S. Forest Service that they're suffering very substantial economic loss from photochemical oxidant damage now in the east. They have in the west for a long time, but we're now convinced in the east that there is substantial damage. Again, I can't give you the figures but it's many, many millions of dollars and this is reflected in decreased annual increment growth; that is, a decrease in the wood let down each year. And when things get really bad during particular episodes it's also reflected in acute injury symptoms on some of the sensitive species.

Now, as I say, we've been monitoring in this province for more about 20 years now I think the ozone levels, and just to give you a perspective: If we consider a crop like tobacco or one of the other sensitive ones, when it's exposed to this -- to 50 parts per billion in the atmosphere; that is, 50 parts of ozone to a billion parts of air - and that's a

pretty low concentration - then you get damage symptoms on some of these sensitive species. The more tolerant species might take 80, but when we get up to about 80 most crop plants are showing damage and a lot of the tree species are showing damage.

Now, we had episodes in 1988 that extended way up past Parry Sound in which the levels were 120 ppb for almost three consecutive days. So we have moved into episodes in which there can be little doubt about the causing damage.

Now, the damage is not always visible damage, that it's not always visible injury damage, it's chronic, and this is reflected on the annual increment growth.

So to answer your first question, is there evidence that we've run into problems? Yes, indeed there is for this. And of course from point sources the sulfur dioxide damage has been substantial in the last -- smelter sources.

Q. And did you want to comment on problems associated with acid rain for forest health?

A. Right. Well, I'm sure that you're well aware that we've had problems of lake acidification taking place in the province and that a substantial number of lakes over the last 25 years have

been acidified to the point at which they can't support either good fish populations or, in some cases, any fish populations and there has been a change due to this change in acidity in the direction of coarse fish, fish from -- basically the salmonids.

Now, coincident with the lake acidification there has been lake chemical changes, additional to the hydrogenion changes. There has been inputs into those lake systems of sulfur in the form of sulphate and there has been mobilization of metals from the watersheds and these include aluminum. So we have in fact toxic concentrations of aluminum in quite a few of these acidifed lakes.

Now, if it's coming from the watershed it stands to reason that there must be effects on the watershed itself because we've got an acid leach taking place, and this is changing the chemistry of the soil. It also of course is impacting directly -- the rain first of all hits the foliage, sometimes it drips through the tree and then hits the feather mosses and so on underneath. So it's rather difficult to quantify what those impacts have been.

We've carried out our own experiments and demonstrated the sensitivity of some of these, particularly the feather mosses actually, they are

remarkably sensitive to acid deposition.

And if you compare the sensitivity to them in experiments with the ambient exposures that they suffer in terms of daily exposure to acid precipitation, they are within coincidence; in other words, they are sensitive at levels which are occurring naturally and there have been observation on species changes. There is a group in Quebec working on this, in some of the Quebec maple forests, which have indicated species shifts; that is, that some of the species no longer apparently are able to survive there.

When we get down to questions about effects on wood volume and so on like those sorts of questions, which are very important, we get -- it becomes more problematic to actually document those.

There's a lot of thought that forests decline which is expressing itself in red spruce decline at high altitude and in sugar maple and beech decline and yellow birch decline and so on in Quebec and Ontario and New Brunswick relates to soil acidification. The soil acidification, of course, is -- the same sort of impacts could occur if we have soil acidification following clearcut, they could be additive.

Q. Could you expand on the term forest

decline and what you mean by that?

A. Well, it's a sort of collective term, it means -- the way it's used really is in terms of the symptoms that you see; that is, the sugar maple that are in trouble showing decline, showing dieback from the top of the branches inwards, the top of the trees downwards. So it's a crown inwards dieback.

And the symptoms include premature fall colours in the case of maple; in the case of conifers there's an old leaf outwards class of needles, so in fact in some of the red spruce decline that is occurring in Quebec in the mountains there you've only got in some cases the last two years' needles instead of having four or five.

This means when you walk into these forests there's a lot more light coming in than normally, even though the trees are not totally defoliated. And this problem is very wide spread. We believe that the problems that we're having through the eastern United States in terms of decline and in Canada in the east and the ones which occur in central Europe, the German ones, the Swiss ones, the ones that have been reported in France and Austria are all part and parcel of a rather similar package; that is, an inability to survive the environmental stresses that

are going on.

Q. Now, in your view, is forest decline a problem in Ontario?

A. Oh yes, it's a problem.

Q. And in what parts of Ontario and with what species do you consider it a problem?

A. Well, the major species that's showing signs of forest decline is sugar maple, it's the commonest hardwood species of the Great Lakes/St. Lawrence Forests. In addition, we have problems with white ash, beech, yellow birch, black cherry, red maple, silver maple around Toronto. There's a lot of hardwood species. In terms of percentage perhaps white ash is showing a highest percentage of white ash but it's a much less common species in the hardwood forest than sugar maple.

In the areas where it's causing concern, again there has been a lot of Ministry of Environment surveys done of this, and there have been a lot of complaints from sugarbush owners of course. The principal areas are on the Shield, the shallow acidic Shield soils around Parry Sound across to Haliburton, Muskoka and north of North Bay there's problems now.

Then there's another area which is in southwestern Ontario with rather different soil types.

There's -- I won't say there's total consensus, but certainly there is rather strong evidence that nutritional problems are at the basis of this; that is, that the trees are unable to any longer adequately supply themselves with nutrients and it can be reversed by appropriate nutrient additions.

The sugar maple is a rather shallow rooting plant, so we believe that you've got surface soil acidification taking place and obviously acid rain is a big component in that. It's acidifying the surface soils, the evidence for this obviously very good in Germany and Sweden, it's not nearly so good here. These roots then also have to cope with toxic level of aluminum going into solution and they can no longer get adequate phosphorus, nitrogen, calcium and so on.

Q. Are there any problems, to your knowledge, with forest decline in the areas of Wawa or Sault Ste. Marie?

A. Wawa and Sault Ste. Marie. Well, there is some sugar maple decline in the areas of Sault Ste. Marie and there has been birch dieback which there has been lots of reports going on for, you know, 40 years of birch dieback, but the reasons -- the causes of that birch dieback, which was very extensive around

Wawa, have never been really clarified. People have looked for pathogens, they have looked for all kinds of things. They haven't come up with a really satisfactory explanation.

There has been -- a similar sort of thing has been happening actually around the Bay of Fundy. The thought around the Bay of Fundy is that it's acid mists. Roger Cox with CFS has been working on this.

Q. Now, with respect to the impacts of air pollutants, how might that change in the future, in your view?

A. Well, I think we are getting a grip on the sulfur dioxide emissions and, therefore, the sulfur component of acid rain has also been changed and I suggest that it has been -- that the ratio of sulfur to nitrogen in the acid rain is moving in the direction of increased nitrogen components.

That's probably a good thing and if we have to have acid rain, then it's better to have a bit more nitrogen in it and a bit less sulfur. There is a lot of experiments which demonstrate that it's not just the pH that is critical, but it's also the chemical properties of it.

Where we seem to be heading --

Q. I think the reporter's having

difficulty hearing you. If you could perhaps try to speak up.

A. Okay. Where we seem to be heading in terms of changes in gaseous mixtures is, there is undoubtedly a substantial ongoing increase in carbon dioxide taking place and that relates us to the greenhouse effects and so on.

We seem to be on the uprise with respect to ozone and we seem to be still going up with respect to nitrogen oxides. But some of the newer regulations for Canada are likely to change the NOX. Part of the problem is we've got more and more automobiles, so even if we start knocking down the percentages which are emitted per car, if we have more and more of them, we finish up with a greater quantity in the atmosphere.

If we get the anticipated climate change with hotter summers, this will push things undoubtedly in the direction of more photochemical oxidants. So the scenario for the future 50 years down the road is likely to be that we're going to have greater ozone and oxidant damage occurring and most likely less sulfur dioxide than we've had in the last 50 years.

Q. And what implication does that have for impacts on forests in Ontario?

A. Well, there will be a natural

selection take place. Those individuals which -- it will be rather like the experiment that we carried out inadvertently around Los Angeles, there will be a sorting out, particularly in the south, of those individuals which can tolerate the levels of ozone to which they're exposed.

But at the population level - that's sort of at the individual level - some will fail and some will make it; most will make it, but in terms of harvest yields and so on, we can expect to be moving into the chronic damage phase; that is, decreases in our wood production from this gradual rise of ozone levels.

Q. Now, is there any concern with regard to air pollution in the boreal forest ecosystem of Ontario?

A. In Ontario. Well, there's local point sources that cause problems and of course the plume from Sudbury certainly has some effects into the boreal forest, but if we're talking in very general terms about the Ontario boreal, I would say that it's much less subject to atmospheric pollution insult than the St. Lawrence/Great Lakes Forest.

Q. Is there any concern with regard to future forest growth in the boreal forest associated

with air pollution impacts?

A. There is concern, there is certainly concern about growth with respect to acid precipitation. The boreal is mainly on somewhat acidic soils, so that makes life a tiny bit easier.

In the south, if we combine that with some of the climatic changes which seem to me to be very likely to take place, then I think we could have a certain boreal in some trouble because it will be hit with some new stresses which influence air pollution. It's likely to lead to some decreases and so on.

As a matter of fact, there was a survey done by the Canadian Forest Service which - I forgot what the technique is - but you ask 40 experts what they think and then compile all the answers. That's basically what they did. And there was a general feeling that the Ontario boreal forest would be influenced by increase in air pollution.

Q. And is it your view then that air pollution will have an impact on long-term wood supply in Ontario?

A. I think we will be getting chronic effects from air pollutants in the southern boreal forest, but this has to be combined with the climatic scenario.

Q. What exactly do you mean by the southern boreal forest, what area are you talking about? There's a map behind you if that's helpful.

A. No, I don't like it is. It's a general statement, so the map -- I wouldn't want to put a point on where the southern boreal forest is. It's not the north anyhow.

Q. Well, can you be a little more specific?

A. Well, okay, I will be more specific for you. It would certainly include places which are transitional roundabout areas north of North Bay, across -- oh all the way across to Sault Ste. Marie and up to Thunder Bay.

So if we say within 100 kilometres of that kind of line we can anticipate some reductions in tree growth due to air pollution, that wouldn't be -- I don't think that would be too bad a statement.

Now, where we put the line and how severe it would be is a bit difficult. But already north of North Bay there are problems, there's problems with the hardwood, the sugar maple north of there, and there is some evidence that white pine has got some problems north of there, and the general feeling is that that relates to air pollution.

Q. That dealt mostly with the boreal forest. Do you anticipate that air pollution will have an impact on the Ontario Great Lakes/St. Lawrence wood supply in the future?

A. I don't like to talk in terms of wood supply. In terms of tree growth, I think that's probably already showing some effects of this.

There's a number of different studies. Danbrook Chronological studies, that is the people who have looked an the annual increment growth, looking at tree rings, and there has been some -- well, I can think of about three or four different studies that have been done on this, some of them have been done just across the border in the States. It's unreasonable to suppose that the hardwood forest just south of us would be totally different in the way they respond to our side of the border, I don't think they recognize the border these trees.

So there has been a downturn in increment growth from about 1960. It's been quite substantial depending on which species and what area you are looking at. One study looked I think at 12 different species and for that - and that was a McCloughlin study, Sandy McCloughlin, the American one - and for that, 8 of the 12 species there was downturn.

Now, they've been trying to, and that is, they have taken out from it - a very clever piece of computer modeling - they have taken out the climatic noise and the annual increment variability from year to year. So when you strip that away you're left with an inexplicable downturn from about 1960 and it represents a decrease in wood increment of about 15 per cent.

Q. And these are Great Lakes/St. Lawrence species?

A. Yes, yes. It includes sugar maple, tulip tree and a bunch of others, but that's not our coniferous species. But of course most of our hardwood forests are much closer to the major population centres and to pollution moving across the United States than the boreal systems are. So you can certainly anticipate that they will be the ones that will be most impacted by the air pollution that's going on.

Q. In summary, are there any other comments you want to give to the Board on the question of air pollution related problems for Ontario forests, or does that conclude what you wanted to say on the subject?

A. Well, if we continued, if we -- you know, if these various treaties with the States didn't work out for whatever reason, then I think we would

have to keep up our concern about the impacts of acid precipitation.

You see, it's considered that soil systems and forest systems are reasonably well buffered compared to, you know, a very dilute lake solution, but the ultimate processes are in the same direction. So it's a question, if we can acidify a lake say in 15 years or 20 years depending on its size - we haven't much to do with the Great Lakes of course because it's so big - but the smaller ones, they have been acidified from the first detection of it in about 20 years.

We can anticipate that the forest soils are moving in the same direction, there is some natural processes which have probably been accelerated by atmospheric pollution. If we don't sort out the acid precipitation problem we will be degrading those systems by acidifying the watersheds.

A lot of the concern that exists at the moment with respect to mercury in fish is that in fact this mercury is being mobilized from the watersheds and it's moving into the lakes where it's being picked up by the fish, and we've got a whole list of lakes which you don't -- you're not supposed to eat the fish or you're not recommended to eat the fish because of mercury levels, and the basis for that almost certainly

is watershed acidification.

The basis for the aluminum problems in the lakes is watershed acidification. Those are all signals to us. It may be that the cadmium problems that are occurring in moose and white-tailed deer at the moment in certain parts of the province is cadmium mobilization from watersheds. There's a lot of signals that watersheds have been acidified.

Q. And what are the --

MADAM CHAIR: Sorry. So, Dr. Hutchinson, you're saying that there are -- when we're looking at air pollution in forests, you're saying there are really two effects; one is a decline in forest growth generally.

THE WITNESS: Yes.

MADAM CHAIR: And the second is the watershed--

THE WITNESS: Yes, that's right.

MADAM CHAIR: --impacts that you've just described.

THE WITNESS: Yes.

MADAM CHAIR: So if you were looking at a prudent way to manage timber, there wouldn't -- what would you do with respect to declining incremental growth, which is one problem; but the second problem of

watershed acidification, does that relate to your earlier point about clearcuts and the increased pace of --

THE WITNESS: Well, it would be one other stress on the system which is in the direction of nutrient depletion. There is a lot of things, especially if we are into the full-tree harvesting which are in the direction of nutrient depletion. And it's like a dripping tap, it's going to put a hole in the system if we don't do something about it.

We are certainly in a position I think to do something about the full-tree harvesting problem, and I think we should be making every effort to make sure we don't, you know, get to the same nutrient depletion system by allowing these forms of air pollution to come to them.

If you want to get a marker, a Great Lakes marker for what's happening you just need look at the water chemistry of any of the lower Great Lakes over the last 50 years.

Aside from agricultural run-off, we have substantive increases in essential elements like calcium in those lake waters now compared with, say, 1910. They are acting -- again, they are the recipients for the watershed run-off from this nutrient

depletion process.

MS. SWENARCHUK: Q. And could you just summarize the problem with this watershed acidification as it relates to Ontario forests.

A. Right. Well, there is one other thing I might add. I have mentioned some of the, if you like, the toxic elements which appear to be showing up in aquatic systems, sometimes inexplicably, which I think we can relate to watershed acidification. The solubility of these components varies.

Q. Solubility of the toxic elements?

A. Yes, say mercury or lead or whatever, varies and a lot of them, if they're coming in from the air they're bound, they are bound in the organic surface.

The four elements which are in trace quantities and which - you know, the ones I mentioned yesterday - which could be second order problems, things like zinc and manganese and so on, there is also evidence that these things have been mobilized from the watersheds.

And the Swedish concern is that because of acidic precipitation they have now, in some of their forests, such a reduction of manganese and zinc and copper that they are running into either present or

immediate future micronutrient problems.

Now, we don't have the evidence here for that, we have some water chemistry, we have some experiments on micronutrient responses in forests and so on, but we don't have any massive evidence, but it will be surprising if we weren't going in the same direction as the Swedish system, bearing in mind we are on the same sort of bedrock, we have the same sorts of forests and we have the same sorts of atmospheric changes in chemistry.

Q. And again, the impacts of this for Ontario forests is what, specifically?

A. The nutritional problems could be accelerated. We could in fact move from potential problems of major nutrient deficiencies to have an add-on of micronutrient deficiencies to it.

Q. Now, if that completes the comments you wanted to make on air pollution problems, I would turn now to questions of climate warming, climate change, Dr. Hutchinson.

A. Okay. Just one little comment, one more thing. This American study on ozone has tracked the ozone levels over a number of years and I have indicated that the general trend has been upwards and to put -- I mentioned 177 ppb, that is one of our

monitors for several days on end; they've got us well beaten. Some of the eastern hardwood sites that they have monitored have over 300 ppb for, in one case, per week. So we hope that they keep most of their photochemical oxidants at home and that they don't come across the border too much.

Q. What's the likelihood of that?

A. Well, unfortunately air doesn't respect natural boundaries, that's one of the problems with acid precipitation and, of course, our highest levels of ozone tend to be in southwestern Ontario and, of course, everyone points a finger at Detroit and Chicago and so on as the source. You also get quite high levels out beyond metro.

Q. Now, are you expecting to see higher levels of these in the forested areas of Ontario?

A. In the future?

Q. (nodding affirmatively)

A. Well, if the present -- there is a climatic -- remember, we've had some very hot summers in recent times and there's a relationship between sunlight and temperatures and photochemical oxidants. So if we continue on that trend and we have this climate warming taking place, which I believe we are already into, then yes.

Q. Let's turn to the question then of climate change in more detail, and I would like you to explain and expand perhaps on the brief introduction to the topic that is in your witness statement starting at page 16.

I will just give you the general question of: What are the factors involved in concerns about climate change?

A. Well, the main one that everyone has heard about is build up of carbon dioxide in the atmosphere. The carbon dioxide is coming from all kinds of fossil fuel combustion, so many of our energy abuses inevitably cause this, from respiration, it's a natural byproduct -- end product of all of the respiration of all of the organisms that exist, that includes microbial organisms as well as the higher plants and animals.

Now, of course there is no reason to suppose that the biomass of plants and animals is increasing, so if we have got an increase going on in the atmosphere, which is world wide and substantial, then we can't really look at the plants and animals and say, you know, they must be the cause.

So obviously fossil fuel combustion is one of the major factors. Natural fires and many of

the agriculturally set fires, both in the tropics and throughout the fire zones, they're also an important factor in accounting for the increase. There are various other sources.

Now, carbon dioxide in the atmosphere, in the lower atmosphere causes a retention of -- prevents the re-radiation of heat, and there is a built up of heat. We have gone from world levels at the turn of century of about 330. When I was in high school we were told it was 330. If you look at any text book now it's about 370 parts per million in the atmosphere. That's a pretty big increase. And you can make calculations as to how much this will cause the atmosphere to heat up and the earth's surface to heat up.

In simple terms, in addition to carbon dioxide there is a number of other gases which will have the same sort of thermal properties and that includes methane and various others, and some of them have a more powerful effect per molecule or per unit of gas, methane certainly does.

And so the way the calculations are done are to talk about carbon dioxide equivalents, and the calculations that people are interested in is: What will happen when we have an atmospheric doubling of the

carbon dioxide concentrations, what will be the temperature effects -- the summer and winter temperature effects, and you can imagine it's pretty difficult to model that, certainly I couldn't try and model it.

They want to know how quickly this could happen given various scenarios, given the present rate of increase say for the last 30 years or the last 50 years, given various energy use scenarios. If we all start burning more and more coal, what will be the consequence of that. What about the combustion of oil. All of these things are moulded into it.

And then they try and put this into circulation models in which they look at the atmospheric circulation patterns for the world as we know them at the moment and try and come up with winter and summer temperatures predicted into the future. Well, you know, we can't get a weather forecast right generally from day-to-day, so there's an area of uncertainty in all of this, a substantial area.

Have we got copies of that --

Q. We have. Do you want to use that document?

A. Might as well. It's useful. I'm only going to refer you to one little picture in this

whole book. So we go from a kind of --

MS. SWENARCHUK: Just wait one second. And an exhibit number for this, Madam Chair?

MADAM CHAIR: Exhibit 1413. Do we have this report on record anywhere else?

MS. SWENARCHUK: I don't believe so.

MADAM CHAIR: And this is an excerpt from Canadian Climate -- what is it an excerpt of?

MS. SWENARCHUK: It's an article by H.G. Hengeveld, H-e-n-g-e-v-e-l-d, in the annual report in 1986 of the Canadian Climate Centre, Atmospheric Environment Service, August, 1987 and it's entitled: Understanding CO2 and Climate.

---EXHIBIT NO. 1413: Article entitled: Understanding CO2 and Climate published in annual report of Canadian Climate Centre, Atmospheric Environment Service, August, 1987 authored by H.G. Hengeveld.

MS. SWENARCHUK: Q. Now, if you would like to proceed, Dr. Hutchinson.

MADAM CHAIR: Excuse me. Is the Canadian Climate Centre a government agency.

THE WITNESS: Yes, Environment Canada.

MADAM CHAIR: Thank you.

THE WITNESS: Well, I think the figure I wanted to draw your attention to is on page 6 of that

document and it's actually reproduced from somebody else's work, that is a paper by Manabe and Wetherland.

Q. I think with the photocoping the figure is not particularly clear, Dr. Hutchinson. So perhaps you could explain exactly what it demonstrates.

A. Oh, okay. Well, let me just go back one step before I do that.

We go from a situation of certainty with respect to the measurements of carbon dioxide in the atmosphere to whether -- you know, to how much that will influence world climate and how quickly.

So as we go into the future the uncertainties gets greater, so we should be well aware that we are dealing with areas of significant uncertainties, especially the further away we get from the present.

And of course the assumptions that are made in some of these models differ. There's a lot of modeling going on, it's a very major series of studies that are going on throughout the world actually. So this is one example and this is one that deals with Canada so it's, therefore, I think of interest to us.

And what the figure shows, the top part of it shows if you have a doubling of carbon dioxide - they don't worry about when that might occur, they just

say if - if we double the carbon dioxide equivalent in the atmosphere then what would be the temperature consequences from that. And let's look at temperatures in the period June to August.

And when I first saw this I was pretty thunderstruck and I guess some people would be. This is sort of bull's eye, which unfortunately is around about Kenora, Winnipeg in the middle of that picture if you can see it. That's a plus 9 degrees celsius increase in temperature anticipated on average for those summer months.

And coming out from there you can see we've got Lake Superior split plus 8 degrees celsius a line down and through Ontario, down through -- Toronto would be somewhere around about 6 to 6.5 degrees increase in temperature.

There is general agreement in all of the circulation models that the temperature increases would be greater in the northern latitudes; that is, the steepness of the temperature increases would rise from the equator. The least effects would be at the equator and then we would have a substantial summer increase in temperatures when would go away from that.

Q. And why is that?

A. Well, there's -- I don't think you

really want to know, Ms. Swenarchuk; do you?

Q. Well, I thought I wanted to know.

A. Oh.

Q. Can you explain briefly, Dr. Hutchinson, given that we're dealing with a province that extends over quite a geographic area?

A. Well, this accentuates the normal continental patterns that exist, okay. So if you imagine that this was the summer and we are going from the coast to the centre, I think you can see that the central parts of Canada in the summer have the highest daytime summer temperatures, okay. So this is super -- this is an overall increase which is superimposed on the present ambient.

The actual increases fall off as you move towards the pole, but I think you can see -- when we say fall off, they've got a line through some of the Arctic islands at plus 4. This means that we're into all kinds of other scenarios like melting ice caps, melting polar seas, and things of this kind, rises in water level at unprecedented rates.

If you put a time sequence onto this; I mean, how quickly could this happen. If it was a thousand years we probably wouldn't be all sitting here discussing it, but if it's 50 years, then it's of major

importance to us. And the unfortunate part seems to be the anticipations are that it will occur within 50 years.

Now, if you call this one, one of the somewhat more pessimistic estimates and you look at -- I think Jim Harrington in his paper refers to some other models and he has a 2.5 to 3.5 celsius increase.

Q. In the same time period?

A. Well, just for the doubling of CO2 equivalent. So nobody really that's been looking at this in detail is suggesting this will not occur; it's a question of how extreme it might be and how quickly it might occur.

When you look at the bottom graph there, and this refers to moisture. Now, the confidence level goes down substantially when you get into moisture, but you can see if you're into hot summer weather it might be nice to be in Kenora with plus 9 in the summer, it might, but if you look at the big black cloud in the middle there over Kenora beneath, that tells you that there's a probability of a minus 50 per cent in precipitation.

Q. From current rates?

A. And this will be in the direction of what's happening on the Prairies. You know, whether or

not the Prairie drying out that's going on at moment and the hot summers we've had, I think four or five of the very hottest in the last 142 years of the whole world have occurred during the 1980s. That could be coincidence, but a lot of people think it is not coincidence, that we're actually into this global warming.

Now, these are changes, if that's true, and these are changes at an unprecedented speed, we've never had anything like it during the occupation of humans on the earth anyhow, the speed, and in fact we would never have had anything as extreme as that.

And so we have to start asking questions about how will human populations and natural populations and plant populations of trees and crops and so on respond or be able to respond to these sorts of changes. As I say, the uncertainties on precipitation are very substantial. On the temperature ones there is much less uncertainty.

Q. With regard to --

A. But we do face some dramatic changes.

Q. And with regard to the uncertainties relating to precipitation, could you just be more clear; is that uncertainty that there will be changes in precipitation, or uncertainty as to the degree of

change in precipitation rate?

A. There will -- it's certain there will be changes, but quite frankly I think there's an awful lot of debate as to exactly where you will get increases and where you will get decreases.

The general thought is it will accentuate the present patterns; that is, that we have limited rainfalls on the Prairies, the grassland areas, and perhaps increased rainfalls in some other parts.

We have the same amount of moisture in the world, same amount of water in the world, it will just be going around faster and faster, evaporating and coming down.

So if you're lucky, you know, this means we're going to -- we're into the business of trying to plan the future with increasing uncertainty, and that's a tricky business.

MS. SWENARCHUK: What time did you want to take a break this afternoon, Madam Chair?

MADAM CHAIR: We can take a break now, Ms. Swenarchuk, if that's convenient for you?

You will be until four o'clock, you don't plan on finishing before then?

MS. SWENARCHUK: It doesn't appear we will, no.

MADAM CHAIR: Well, why don't we take our break now then.

MS. SWENARCHUK: All right. Thank you.

MADAM CHAIR: Thank you.

---Recess taken at 2:35 p.m.

---On resuming at 2:55 p.m.

MS. SWENARCHUK: Q. Now then, Dr. Hutchinson, would you turn your attention to the anticipated impacts of climate change as you have described it on Ontario forests?

A. Well, there are a whole series of anticipated impacts obviously again with uncertainties attached to these. One of the publications that's looked at this has suggested that there will be an incursion into the Kenora region from the Prairies of grassland; that is, there will be a drying out which you can see might be the case from that data I gave you, and a warming up, and this would cause an extension of the Prairies into the southern part of the boreal in the Kenora region.

Now, some of the suggestions are that that could be a substantial incursion and that you would have displacement north and east of the boreal forest.

The other -- a number of people have

looked at the tolerances of present boreal forest species and present Great Lakes/St. Lawrence species, the present ranges of tolerance in terms of temperature optimum and so on and have anticipated where they might finish up given this doubling, that may not be where they finish up, but given a doubling. And in the north, of course, assuming they could move fast enough to achieve that and -- well, let me just -- I think I have a few figures.

Q. Excuse me, what did you mean by that, assuming they can move fast enough to achieve that?

A. Well, I mean, some of the changes will be so fast that I don't think they could be achieved in terms of natural dispersal. The changes coming on in 40 or 50 years' time would mean that we might have distressed forests unable to achieve any kind of new equilibrium in that time period.

Q. Okay.

A. We would have to wait a longer time than the doubling CO2 time to achieve that equilibrium.

Well, I think I can remember the figures actually. The smallest estimate of about six different studies is that there will be a northwards displacement of about 90 kilometres. The largest estimate I think is 720 kilometres displacement northwards, the southern

edge of the boreal.

In other words, there will be a migration of the boreal forest northwards. So again, if we take sort of North Bay/Sudbury line, then when we reach the boreal somewhat north of that. That would be gradually infiltrated by St. Lawrence/Great Lakes hardwood species and it will -- obviously it cannot take place instantaneously and, therefore, there will be problems in terms of the trees that are moving out of their tolerance limits, the tolerance -- the temperatures will change some trees will simply find themselves unable to maintain themselves.

Okay. So there will be decreases in growth. There might be initial increases in growth due to the increased temperatures, but then there will be decreases as they run out of tolerances.

Q. Now, excuse me. Do the studies indicate to what species that may occur?

A. Well, these would be to black spruce, white spruce, jack pine, boreal forest species.

Q. Fine.

A. And in that region it would be the northward movement also of white pine and red pine. I should find you the actual figures, if you will just bear with me for a moment, okay.

The same thing would be happening of course in Scandinavia, we would go lock-step in this. So here's one report which suggests, Kaupii and Porsch, the 500 to 1,000 kilometres northward movement of the boreal forest.

Another one founded in 70 to 920; another one, a Canadian one, 80 to 720. See, the Canadian one gives itself a lot of leeway, 80 to 720, another 250 to 900, and a fifth one, 100 to 930.

These are very substantial shifts in northwards of the boreal southern limit.

And at the other end it won't stay just jammed up against the tundra, it will move out onto the tundra and there will be a northward expansion of the tundra. The permafrost regions in the north will melt out, they will be reduced and you will have, you know, deeper active layer and ultimately no permafrost frost in some of these regions.

There is other - and I think it was Harrington's study from the Canadian Forest Service - who suggested that there will be a lot of open water on James Bay and Hudson Bay and this will cause increased evaporation from those surfaces causing increased moisture immediately south of Hudson Bay and James Bay. So the James Bay lowlands area are likely to get wetter

and hotter.

Q. And what impact would that have on forest issues?

A. Well, some species are going too find themselves -- if it gets a lot wetter in the Hudson Bay lowlands some species are going to be inundated because, quite frankly, it's already very wet there. It's one of the major wetland areas in the world actually.

The northward shift onto the tundra means that we would have productivity shifts, increases in productivity at the northern end of the boreal and probably decreases at the southern end as species find themselves unable to cope with the changes, so if you can imagine an infiltration of the Prairies from Winnipeg towards Kenora and further north from there into the boreal.

There is yet another estimate that there will be a substantially reduction of overall boreal forests actually, and some of the estimates - I'd say guesses - but estimates for that are very, very large actually in terms of hectares.

Q. Very large reductions?

A. Yes, very large reductions. Nobody is suggesting there will be an increase in the boreal.

Some people are suggesting there will be a decrease overall in the boreal.

But, you know, when we're dealing with almost the migrations of floras, superimposed under a very short time period, the uncertainties as to how the plants will cope and how the populations will cope, you know, we don't know frankly.

MADAM CHAIR: Dr. Hutchinson, how does this information fit into the decision that this Board has to make about approving a timber management plan?

THE WITNESS: Well, if I have convinced you that the uncertainties will increase and that these climatic changes will take place, then we're moving into a period in which the predicability of annual increment growth of wood becomes more problematic.

If you combine that in the south with the probability that the trees will find themselves simply in trouble and perhaps unable to survive, almost during the next lifetime of the trees that we're planting now, then the estimates of wood supply I think get a big question mark on them. We move the uncertainty of how the trees will respond reflects itself on the uncertainties of wood supply, I believe.

MADAM CHAIR: So practically are you saying that we shouldn't plant trees in Kenora?

THE WITNESS: We should plant the right trees in Kenora perhaps. It's possible to do some -- since we think this is going to happen and we're in a position to monitor it, we're in a position to make some moves which might be appropriate to try to anticipate this.

I mean, it's not all bad news. We're likely to be increasing the boreal north onto the tundra and we're likely to increase in the middle of the boreal perhaps the rates of annual growth, but I would say that we would be well advised to take a somewhat conservative view on estimates of our timber production in view of these uncertainties, and it's unlikely that things will settle out.

And it wouldn't stop there. I mean, if we anticipate doubling in 50 years, then we stop thinking about it at 50 years, but what happens at a hundred years, what happens at 75 years. These are important questions.

MS. SWENARCHUK: Q. So just to --

A. Can I mention a few more things that will happen?

Q. Yes, please do.

A. Which we believe. Obviously there is a relationship between climate, especially summer

drought, snow melt and things of this kind and fire frequency, and all of the predictions that one gets for the boreal system is that fires, of course, will continue and the frequency - and some people say the intensity too - is likely to increase. So we're very probably moving in the direction of increased fire frequency in the areas.

Now, I'm not saying that the evidence from the 70s and 80s is in that direction, but it could be interpreted that way. It's not at variance with this. So it's possible that that has already been reflected.

Now, you could also argue: Well, what happened in the 1920s when we had the biggest fire we've ever had. So, as I say, it's not variance with it but it's certainly not proof in any sense.

There will be influences on pest populations and people like Harrington and Pollard and so on and the Deputy Minister, Dr. Maini is suggesting that there is likely to be increases in pest outbreaks, and that includes Ontario, and they're suggesting that B.C. will have some substantial changes, and these will be in the direction of increases.

The melting of the permafrost will release nutrients so, we certainly could ultimately

have benefits in the far north in terms of how much tree growth takes place there, but whether it will be enough to compensate for the losses in the south is a different question that we can't answer.

The migration of the hardwood species will take place further north, but again we might have some of them finding themselves outside of their ranges of tolerance. We just kind of shift everything up north. It's gone up and down, you know, before and after the last glaciation, well it's probably going to be moving north, only this time instead of having 10,000 years or whatever, we're looking at those changes taking place over about 50 years to 70 years.

It's very difficult to plan for such things. It's difficult enough to plan if we assumed everything was exactly as it is now, but when we're trying to plan for the future, especially with forests, where we have to make plans for 50 years down the road, this is basically a real nuisance.

With agriculture it's a little bit better because you can kind of do it year by year, you put in annual crops in and you can make your shifts, you can borrow some of the seeds from the States and start planting them here, other varieties, but we should certainly be examining our selection of progeny, seed

progeny for the species that we're planting out at the moment and be having a lot of consideration of how best to do this in future. The things we're planting now will probably be harvested when these changes have already gone quite a long way down the road.

Q. Now, do you have in mind particular types of progeny that we should be selecting where we are planting?

A. Well, perhaps you would looking at drought tolerant seed.

MR. FREIDIN: Sorry?

THE WITNESS: Drought tolerant, temperature tolerant progeny. I suppose we considered this greatly, Ms. Swenarchuk, but if we were planning for more fire, then we would perhaps be planning for more fire tolerant species. We would need to be making the moves in the southern boreal forests, probably before we need to make them in the mid and in the north boreal forests, so the closer we are to the line I have indicated, the more we need to become concerned about what we're planting now.

I don't think this is a theoretical exercise. I mean, I do believe that the evidence, and I haven't -- you know, there's a lot of other evidence that I haven't mentioned at all about earth

temperatures which have increased in both northern hemisphere, sea temperatures which have increased and -- well, I will give you one example that I think is pertinent about some work that has been done from the experimental lakes region which is north of Kenora, now that just happens to be in the black spot, bull's eye on the map.

Dave Schindler at the Fresh Water Institute at Winnipeg has led a large group working out of Kenora out of the experimental lakes there for about 20 years, 25 years and amongst the many things they have done is, on a yearly basis, monitor the productivity of the lake systems in the experimental lakes area.

They have also monitored the water temperatures with great intensity, they have also looked at the time of ice out in the spring for these lake systems. They measure snow depth at the first of the month throughout the winter months and, of course, there is a lot of noise in the system.

Q. What do you mean by noise?

A. Well, I mean there's a lot of seasonal and yearly variation because we're dealing with major responses to climate of climatic effects. Okay.

When they have calculated -- when Schindler's calculated what's happened over the last 20 years, as a result actually of our own society meeting, he has decided: Well, funny enough he has one of the longest data sets that exists for this sort of measurement and it happens to be right in an area where we might expect to get one of the earliest signals of climatic change.

When he does that, he finds that over the last 20 years there has been a one degree celsius increase in temperature in those experimental lakes area, that is taking account of the noise. There has also been a decrease in snow depth and there has been a move forward of ice out in the spring from these lakes.

The best data, however, is freeze water temperature data, and coincident with that is an increase in primary productivity in those lake systems. So he thinks there is a correlation between the increase in water temperature in the summer months by one degree celsius and an increase in productivity of algae, primarily produced plankton, phytoplankton, and that's taken place in 20 years.

Now, Pete Dillon has been looking at a similar record which we have for about 12 years for the Dorcet Region here -- and actually I haven't heard about

what he found - but we do have a few data sets like this which are really precious. We have got to try and get these data sets together to see if we can pick up these early signals.

Now, I think it's significant that in the Kenora region and very fortunate that we happen to have this incredible data set that has been collected very carefully for a long period of time, and it's in direction of, you know, climate warming.

Q. The question of what the Board and timber managers do in relation to this issue is obviously a considerable concern to the Board, Dr. Hutchinson.

Would you just like to summarize once again for us what you think should be done now and in the coming years in, say, forest management in Ontario in response to the assumed trend towards climate warming?

A. Right. Well, in the most practical terms we have to try and build in safeguards for the future which would take these trends into account, and aside from trying to, you know, keeping a watching brief and doing experiments and so on to see what progeny should be planted and what species should be planted where, the most obvious thing to me anyhow is

that we should take account of this uncertainty in terms of the timber yields that we can anticipate, and if we do anything at all with those, I think we would probably have to scale them down from the present.

Now, that would be conservative, and we may be proven wrong on it, but it would be a very sensible thing to be doing, to look at this from that point of view. It's most unlikely that there's going to be a substantial increase. It's also apparently very unlikely that it's going to be the status quo, and the combination of some of the temperature and precipitation changes that we're getting into, with some of the impacts of air pollutants which are going to be accelerated, the photochemical oxidants that I have mentioned will be accelerated, the main one is the climate change, all in that direction; increased pest epidemics, increased fire episodes, and so on.

That all adds up to something rather negative, frankly. But the other end of it, as I say, in the north we can then maybe start making plans for the future as to what we're going to be planting out on the tundra, but that's going to be -- you know, the benefit of that I think will come in well after the disbenefit of what's going to happen in the south.

MR. FREIDIN: Madam Chair, I'm just

wondering whether Ms. Swenarchuk can advise whether any of the other panels are going indicate the actual method by which this scale down of timber activity should take place? Is that the subject matter of one of your other panels?

MS. SWENARCHUK: Could you clarify the question, please?

MR. FREIDIN: Well, I understood the witness to indicate that we should take into account this evidence in terms of timber yields in the future and there would have to be some sort of scaling down. And what I'm asking is: Are any of your panels going to provide any assistance regarding how that might be done in a practical and reasonable way?

MS. SWENARCHUK: Yes, that issue will be raised in Panel 5, Mr. Freidin.

MR. FREIDIN: Thank you.

MS. SWENARCHUK: Subject to any further questions from the Board on this issue, I would leave the issue here and turn to something else.

Q. Dr. Hutchinson, in your witness statement Panel 1 -- do you have witness statement No. 1?

A. Right.

Q. Page 3, you have made a comment with

regard to soil compaction in harvesting.

A. Oh yes.

Q. This is at page 3, beginning on the eighth line.

A. Right.

Q. "Soil compaction is a result of mechanical skidders and more recently of giant feller bunchers and forwarders whose tracks and tires cause extreme compaction of the large clearcut sites where full-tree removal is practised."

Let me ask you first, are you aware of any studies that have identified the degree of soil compaction across the Ontario forest?

A. No.

Q. Could you indicate then the source of the concern that you express here and expand on why you think it is a matter of concern?

A. Well, the concern comes from, and my own concern comes from a number of different sources. One is discussions with other colleagues who have observed this, some of my own observations on compaction and rutting which I have seen at sites in the north, and from literature where this is indicated, in some cases measured, but not in this province.

Q. And what exactly is your concern with regard to the effects of soil compaction?

A. Well, soil -- if we accept that soil compaction is likely to take place from running very heavy equipment across sites, then my concern is that it's of this type, that this is creating a less favourable environment for future growth of anything you wish to plant in it, and there's good evidence that where compaction does occur that this is inhibitory to plant growth.

Okay, so there will be effects on productivity. It also can cause what one might call ponding and this means it's rather difficult to get trees to establish under the waterlogged conditions that can be created.

Now, I should say that the compaction and rutting is worst on sites which are wet. I mean, that is fairly obvious and, therefore, it's obviously a problem of summer months and it's a problem on soils which are going to be waterlogged on which the water table is near the surface and obviously on soils in which you have finer soil particles.

So it's going to be a problem in terms of wet soils and it will be less in terms of effects on sandy soils and gravels and things of this kind. It

will be worst on silts and clays.

Now, the areas which are affected by this -- obviously there is some ways around it, and I think this has been referred to already actually in previous evidence. I read somewhere that -- that high flotation tires were used on some of the equipment, but if I recollect correctly I think the use of this amounts to something like 15 per cent of the use in the province; that is, the equipment was -- 15 per cent was equipped with high flotation tires. That being the case then there's 85 per cent not fit with high flotation tires.

And the relative compaction -- we can certainly reduce compaction a great deal as they do in the Arctic regularly by putting high flotation tires on equipment, and then it's a question of having access to sites at times of the year when compaction -- if you're using non-flotation tires, if you're using conventional tires, accessing the sites when they're frozen.

So I would make a series of recommendations which have been made by others of course, that we not be accessing sites with this heavy equipment in summer months on sites which are susceptible to damage; that is, sites in which you have a high water table or have already wet or waterlogged

conditions, especially on clays and silt sites, et cetera, and the summer exceptions might be, of course, sites which have coarse particles and low water table.

Q. You mentioned that compaction can influence the speed of recovery of the site. Does it have any influence on the plant community that becomes established on the site?

A. Well, it certainly does. If you're talking about natural revegetation of sites which are rutted and waterlogged by use of heavy equipment of this type, then there is a tendency to get, you know, species which are tolerant to those wet conditions growing there, and in central Ontario cattails would be one example of this, and cotton grass would be another, Northwest Territories where I have seen this, it's particularly cotton grass grows there.

Q. Are there you any other comments -- go ahead.

A. Well, there are actually a number of studies, as I say, that I have looked at it. The weight of some of this equipment is -- it would be no surprise if there was compaction frankly from the size of the equipment that's being used.

Here's one example of a feller buncher, the Koehring Waterous 628 Feller Buncher which weighs

73,000 pounds, that's unloaded, so...

MR. FREIDIN: What's the reference, please?

THE WITNESS: It's what you might call -- it's not really a reference, it's an advertising thing from Koehring Waterous.

MR. CASSIDY: Well, perhaps what we can do, Ms. Swenarchuk - and I think she's agreeable to this by the sound of it - making copies and providing us with it.

MS. SWENARCHUK: Yes. Could you just identify exactly what you're reading from first.

THE WITNESS: Okay. I don't see much identification. It's one of these action card things where you send in for information. Oh, I'm sorry. Okay, Logging Sawmilling Journal, November, 1989.

MS. SWENARCHUK: Q. Is there a page number?

A. Action card No. 104.

Q. Now, Dr. Hutchinson, in your view, could equipment of that size and weight be equipped with, is it a tired or tracked vehicle, first of all?

A. Well, that one is a tired vehicle.

Q. I think we have heard that equipment that large cannot be fitted with high flotation tires.

A. I don't know about that.

Q. Are there ways that you could suggest that equipment of that weight could be equipped so as to minimize danger to the site, or given the size of it is that, in your view, not possible?

MR. FREIDIN: The witness just finished saying that he didn't agree with your suggestion that they couldn't be fitted with high flotation tires, so I'm not sure --

MS. SWENARCHUK: No, no.

MR. FREIDIN: Or he didn't know.

THE WITNESS: That's more accurate, I said I didn't know whether it was feasible to fit these with high flotation tires. Yes, I do believe actually in this case it is. I believe this reference here is to high flotation tires.

It tells you the ground pressure which is generated, which looks as if it's appropriate to high flotation tires, and I have got various other things here which indicates the sort of --

MR. CASSIDY: Well, Madam Chair, I don't think he's qualified as an expert in equipment, so we're getting into evidence again which is outside his area of expertise, and he's already indicated a tremendous degree of uncertainty in answering the

question, so...

MADAM CHAIR: Ms. Swenarchuk, your questions about this have to do with...?

MS. SWENARCHUK: Really whether the weight of the vehicle of this size in itself is likely to cause compaction, that's my question.

THE WITNESS: I can only make the comment that if you have a vehicle of 73,000 pounds loaded -- unloaded running about on a wet site which has got silt and clay in it to a significant percentage, it would be astonishing to me - but not as an expert - if it would be astonishing to me if it didn't cause some compaction. I certainly wouldn't want it to run across my foot under those circumstances.

However, there are other references in which people have actually looked at the compaction caused by vehicles with conventional tires versus flotation tires and what the effect of feller bunchers are with these equipped.

There's a paper here which I will mention the reference for you, it's by Novak, it's called Downsizing Skidders with High-Flotation Tires, it's from Extraction and Processing Technical Note, TN-113, January, 1988.

And the study itself looks at the

compaction caused by two sets of equipment. I'm not sure if it's going to help anybody if I read out the sorts of equipment used, perhaps it will.

> "The relative performance of a John Deere 540B (67 kW) equipped with Firestone 66x50-26 (Flotation 23 Logger) tires was compared to that of a modified John Deere 640B (90 kW) equipped with conventional...tires and chains all around.
>
> The largest skidder was also equipped with a hydraulic grapple mounted on the side of the blade. This option facilitated bunching and reduced the time required to pick up individual and/or dropped trees in the cut-over or along the skid trail."

Okay. So that's the equipment that was used. And what they did was they dropped the trees on the site and then they used these two sets of equipment at one site in Quebec, in parallel, to see what the relative effects were; one fixed with -- fitted with conventional tires and the other with flotation tires.

Okay. And the site they looked at was wet, so it was probably not a good idea to do it when

they did it, but anyhow it was wet. They measured the amount of rutting. They said: Well, the percentage of -- okay, let me just read this out.

> "In each test strip, about 55% of the area showed evidence of skidder passage (i.e., tire tracks). This is nearly double that observed during earlier experience and was probably a consequence of the higher than average rainfall for the region during the test period. The wet ground conditions forced the operators to seek untravelled areas to maintain adequate traction, thus increasing the total ground area traversed."

That really I think just emphasizes the undesirability of doing this sort of thing on wet sites, summer months, wet sites.

> "While the percentage of rutting was similar for both machines, the degree of disturbance was not. With the high-flotation tires, only 17% of the ruts were more than 16 cm in-depth, whereas with the conventional tires, 93% of the ruts exceeded this depth.

In general, the improved flotation and decreased ground disturbance provided by wide tires on sensitive sites resulted in an improved regeneration potential." That is for subsequent regeneration with vegetation.

"The smaller machine's lighter weight (-17%) also contributed to reduced site damage."

And they actually went through operating costs, including these sets of equipment.

MADAM CHAIR: Ms. Swenarchuk, are you having another witness who will be addressing compaction matters?

MS. SWENARCHUK: Yes, yes.

MR. FREIDIN: Can we have the reference? We would like a copy of that document as well, please?

MS. SWENARCHUK: And we will have to make these two exhibits.

MADAM CHAIR: Separate exhibits?

MS. SWENARCHUK: I believe so, they're separate documents.

So the reference from the logging and Sawmilling Journal of November, 1989, will be Exhibit...?

MADAM CHAIR: 1414.

---EXHIBIT NO. 1414: Action card No. 104 from Logging and Sawmilling Journal, November, 1989.

THE WITNESS: The point that I've got from a number of these papers is that the use of flotation tires would substantially improve the problem. High-flotation tires don't eliminate compaction entirely, but they certainly mitigate some of the worst features of it.

And the other point is, it's the number of passes that you make that determines the degree of compaction and rutting that occurs.

And I guess the last important point is one that I have repeated ad nauseum, that use of this equipment on wet sites in the summer months, particularly where you have got a high sand and silt percentage, is likely to lead to problems, but it's the number of passes that you make that's important.

MS. SWENARCHUK: Thank you, Dr. Hutchinson. So the Novak paper then will be...?

MADAM CHAIR: How do you spell Novak?

MS. SWENARCHUK: N-o-v-a-k, Downsizing Skidders with High-Flotation Tires will be Exhibit 1415?

MADAM CHAIR: How many pages is that article?

MS. SWENARCHUK: Six pages, Madam Chair.

MADAM CHAIR: And the date on it?

MS. SWENARCHUK: January, 1988, and it's published by FERIC, Forest Engineering Research Institute of Canada.

---EXHIBIT NO. 1415: Six-page article entitled: Downsizing Skidders with High-Flotation Tires, published by FERIC dated January, 1988.

MS. SWENARCHUK: Excuse me.

Q. Dr. Hutchinson, I want to turn now to your experience with and observations with regard to nursery container stock production in Ontario.

MR. FREIDIN: What expertise does he have in relation to that subject matter, Madam Chair? I don't see anything in his curriculum vitae which even remotely touches on the production of seedlings in Ontario or anywhere else.

MS. SWENARCHUK: Well, perhaps we could ask him first, Mr. Freidin.

THE WITNESS: Well, what's the question going to be. I would like to find out whether I have expertise to answer the question.

MR. FREIDIN: I suppose I should perhaps await the question.

MR. CASSIDY: No one could ever accuse

your examination of being rehearsed, Ms. Swenarchuk.

THE WITNESS: What's the question?

MS. SWENARCHUK: We'll discuss that later, Mr. Cassidy.

MR. CASSIDY: I didn't mean it as an insult.

Q. Dr. Hutchinson, have you ever visited the nursery production -- the seedling production nursery in Swastika, Ontario?

A. Yes.

Q. And over what time period have you visited it?

A. Well, I have probably visited it sort of once or twice per year for each of the last about 12 years.

Q. And are you aware of the number of seedlings produced in that nursery each year?

A. Not exactly, but it's quite a few million of seedlings. It's a fairly large nursery.

Q. Now, do you have any comments on how the conditions of production of the seedlings in the nursery may have an impact on the capacity of the seedlings to survive once transplanted into plantations?

A. Okay. The seedlings there seem to be

raised under very good conditions, it's a terrific operation and they are watered, irrigated on a continuous base, they are grown with suitable fertilizer conditions in very good soil, they are raised under, you know, ideal conditions and they're frequently initiated in greenhouse structures.

Q. And what are your observations then of the impacts on these seedlings when they're transplanted into plantations?

A. Well, there's a sort of gap in my observations between in the nursery and seeing seedlings in the field. I can only comment -- I mean, I will make a comment on this; that is, that it's maybe slightly puzzling that we're raising seedlings just marvously in my opinion - that's a terrific operation - but we're raising them under such ideal conditions that we're then putting these unfortunate seedlings out into frequently very nutrient poor, extremely inamenicable habitats.

And I don't know -- you know, from the sorts of experiments we've looked at in terms of survival and nutrient deficiency, it seems to me that we are maybe moving in, almost to putting hothouse plants out into the bush.

I know a lot of people have commented on

this in the past too, but I'm not sure if it's - I don't know - but I'm certainly not sure if it's the best way of doing it. It's the best way of raising seedlings, but it's not the best way of then putting them out in the field. That is the concern I have.

Q. Well, as a botanist --

MR. MARTEL: Can I ask you a question? Would they not be healthier and consequently the chances of survival be greater because of the fact that when you plant them they're healthier?

THE WITNESS: Well, you know, sure that's a point of view. They're bound to suffer a pretty severe shock when they get out there. Now, whether that enables them to do better than putting rather more natural nutrient poor seedlings out there, I don't know.

From totally different experiments we find that nutrient poor seedlings survive rather well under adverse conditions. It's like they've had a hardening process from it but, you know, it's a bit difficult to jump from some experiments we've done on nutrient deficiency to this situation at the nurseries. It's just something that is perhaps worth raising as to whether this is the best way of arranging for things to enter the world.

MR. MARTEL: We had all kinds of evidence in the last couple of site visits, or hearings from people who do in fact produce trees who gave evidence to the effect that the survival rate of the trees that they started and then ultimately were planted that the survival rate was much higher than, let's say, six or seven years ago when maybe the production wasn't done as efficiently. There seems to be a...

THE WITNESS: I haven't had the opportunity of really following up the survival of the seedlings from that site. I mean, as I say, there's a gap from seedlings there and what I'm observing in the replanted sites.

I mean, obviously they have some failures in the replanted sites. Now, this is sort of a big jump to say that that relates to what happens in the nursery. I don't know that at all.

MADAM CHAIR: Dr. Hutchinson, are you familiar with the overwintering process that's used sometimes to keep seedlings stacked outside and covered in some way over the winter?

THE WITNESS: Mm-hmm.

MADAM CHAIR: Does that sort of process make a plant hardier, I suppose it wouldn't in terms of nutrition status.

THE WITNESS: I think it would make it hardier in terms of its ability to survive fluctuations in temperature. It's actually a common way of dealing with non-forestry commercial nursery situations, overwintering the stock.

MR. FREIDIN: What term or condition is Forests for Tomorrow seeking, if any, in relation to this evidence, Madam Chair?

MS. SWENARCHUK: Well, I think that's an issue for us to deal with at a later time, Mr. Freidin. I don't know any reason to raise it now. You will be seeing our complete terms and conditions when they are produced.

MR. FREIDIN: Well, Madam Chair, I think I may raise this formally at a later date, but it seems to me that to cross-examine a witness who is giving evidence about a certain topic, it would certainly scope my cross-examination and I think would be more helpful to all the parties and the Board if we knew what the evidence was attempting to support by way of a term or condition.

It may very well be that this evidence is very helpful in relation to term and condition "x", but not very helpful in relation term and condition "y", and it seems to me that it would be most helpful to

know what the evidence is aimed towards.

MS. SWENARCHUK: Yes, that would have been of assistance to all of us doing cross-examinations during the Ministry's case as well, I guess, Madam Chair.

MR. FREIDIN: Terms and conditions were submitted as part of our case, Madam Chair, and I will perhaps deal with it more formally later, but it's a matter of some concern to me.

MS. SWENARCHUK: Q. Dr. Hutchinson, I would like to turn now to ecological issues relating to the use of artificial versus natural regeneration techniques.

A. Mm-hmm.

Q. Now, in your view, do any ecological concerns arise from the reliance or from a reliance on regeneration technique of single species plantations?

A. Well, there is some obviously agricultural parallels but how parallel they are is debatable. If we plant our monocultures, particularly if we have limited genetic diversity in that monoculture; that is, we're using limited genetic progeny in it, then we could set ourselves up for problems if some disease comes along or some insect comes along that can access that monoculture, because

if it can access part of it, it can access the lot. So there is that sort of problem.

Of course we've got, as I say, a lot of agricultural examples of that. The agriculturalists are continuously having to change their crops, alter the crop resistance genetically to cope with the constant attempts of insects and fungal pathogens to get in there and exploit the monocultures.

And certainly there has been some concern that we might be move in that undesirable direction with forests; that is, we've reduced the genetic diversity and we would also, by monoculture, we're providing a huge food source for something that would like to eat it.

Q. Now, it has been said that some stands, some natural forest stands, for example, we speak of black spruce stands or jack pine stands, essentially are a type of natural monoculture.

Are there differences, in your view, between natural monocultures of that type and their susceptability to pests and monocultures which could be developed from artificial regeneration plantations?

MR. CASSIDY: Madam Chair, I don't mean to interrupt, but I'm having difficulty following where this might be in the witness statement. And could you

just assist me, Ms. Swenarchuk, and give me an idea where I might find this in Panels 1 or 1A?

MS. SWENARCHUK: Well, as has been the case with many other witnesses, including Industry witnesses, not absolutely every issue is specified in the witness statement. Virtually all of Dr. Hutchinson's testimony does appear there, of course, in outline.

This is another area which we intend to deal with rather briefly, Mr. Cassidy.

MR. FREIDIN: Well, Madam Chair, I would like to rise and perhaps object more formally. This witness has been testifying in relation to a multitude of subject areas and, as I indicated earlier, I intend to question him on that matter.

But again, there is nothing in his CV which indicates he has any expertise in the area of insect infestations in terms of their effects in the boreal forests or otherwise. We called experts in relation to that matter. I don't see where the expertise arises on this witness and I object to the question.

MS. SWENARCHUK: Well, Madam Chair, the expert has been qualified with expertise in botany and particularly with regard to applied forestry ecology

and perhaps Dr. Hutchinson would like to add to the discussion, but can there be any doubt, seriously, Madam Chair, Mr. Martel, that a professional forest -- professional professor of botany and forestry ecology should be well aware of issues such as susceptability of forest species to pest infestations.

MR. CASSIDY: Madam Chair, I still -- I have two concerns that arise as a result of this; one is, there is nothing in his witness statement that even remotely comes close to that - unless Ms. Swenarchuk can direct me to it, I can't find it - and I think there is, as I understand it - and perhaps you can correct me if I'm wrong - there is going to be evidence from other witnesses that she's going to call that might deal with this subject matter for which evidence has already been prepared in the form of witness statements, and she can correct me if I'm wrong on that as well. But in addition, we have been hearing -- so I have a concern about the documentation that has been provided and then the evidence that ends up being adduced here at the hearing.

And my other concern is that we were talking about genetic monocultures here and her question was in relation to genetics, and I don't think he was qualified as a geneticist.

So I have two concerns with respect to this line of questioning. I would like them addressed more fully then simply saying it might have been done in the past. I don't recall any situation where evidence which was not in any way in a witness statement was then introduced in a hearing in some fashion.

Now, if there is something in here, I will be very happy to hear about it from Ms. Swenarchuk.

MADAM CHAIR: Dr. Hutchinson, can you briefly state for the Board the experience you have had with respect to the two issues of monoculture that Ms. Swenarchuk wishes you to talk about now; and, that is, the genetic resistance to disease and pests that...

THE WITNESS: Well, my experience with monocultures and pests relates particularly to crops and fungal attack, it doesn't particularly relate to forests and entomology, but there is obviously some parallels, and I think Ms. Swenarchuk is attempting to make some of these parallels.

MR. FREIDIN: Just because there is a parallel, Madam Chair, doesn't mean he can talk about it; anybody can talk about it, in my submission.

MADAM CHAIR: Ms. Swenarchuk, are we

almost at the end of Dr. Hutchinson's examination-in-chief?

MS. SWENARCHUK: Yes. It appears that there will be about one hours' testimony to be put over to next week, but apart from that we're just about finished.

MADAM CHAIR: Okay. One minute, please.

---Discussion off the record

MADAM CHAIR: Ms. Swenarchuk, I think the Board will rise now. You've got another hour to do on Tuesday morning?

MS. SWENARCHUK: Yes. I would like to put some questions to him with regard to expertise in this area.

MADAM CHAIR: It's getting near the end of the day. The Board suggests that you plan what the cross-examination will be in this area and why Dr. Hutchinson has some expertise in this area, and start at that point first thing on Tuesday.

MS. SWENARCHUK: Very well.

MR. CASSIDY: Madam Chair, I have a further request, and this may sound a little unusual, but I think it may save some time. Mr. Hutchinson referred to the issue about high flotation tires, he said he had read somewhere that it had only been used

15 per cent of the time.

MS. SWENARCHUK: I will provide you with that, Mr. Cassidy.

MR. CASSIDY: Well, just a second. But what I'm interested in is if he's read that in the transcript, if Ms. Swenarchuk can provide me with the transcript reference that he referred to.

THE WITNESS: Yes, that was in the transcript somewhere.

MR. CASSIDY: All right.

MS. SWENARCHUK: It's in an interrogatory response received from the Ministry of Natural Resources during their Panel 10, Mr. Cassidy. I'll provide it to you.

MR. CASSIDY: All right. So it wasn't in the transcript?

MS. SWENARCHUK: No, it was interrogatory response. Very well, Madam Chair.

MADAM CHAIR: Thank you, Ms. Swenarchuk.

MS. SWENARCHUK: That will be ten o'clock Tuesday?

MADAM CHAIR: It will be ten o'clock on Tuesday morning.

---Whereupon the hearing adjourned at 3:55 p.m., to be reconvened on Tuesday, October 9th, 1990, commencing at 10:00 a.m.